SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1907.

GENERAL PHYSICS.

949. *Mechanism for controlling the Application of a Blow.* **E. Sauvage.** (Bull. Soc. d'Encouragement, 109. pp. 234–245, March, 1907.)—The principle described can be applied to machines in which a pressure is to be rapidly produced, as in a stamping press, or in which a number of blows are to be given in rapid succession. A crank-pin engages in a slot in the piece to which the rapid reciprocating movement is to be applied (as, *e.g.*, the cross-head of a power-hammer). There is a depression in one wall of the slot, however, so that during the power stroke the crank-pin does not affect the movement after the maximum velocity (equal to that of the crank-pin) has been acquired by the head. The intensity of the blow may be limited by altering the depth of the depression, which consists of two pieces forming a V. The application of the principle to several types of machines is described with sketches. Luc Denis is the originator. F. R.

950. *Reliability of Thermographs for Balloons.* **A. de Quervain.** (Beiträge z. Physik d. freien Atmosphäre, 1. p. 168, 1906. Zeitschr. Instrumentenk. 27. pp. 127–128, April, 1907.)—The author continues the work of Hergesell and Maurer by testing the thermographs used on balloons in the international ascents. These are chiefly (1) the small Bourdon thermograph of Teisserenc de Bort, German-silver tube, slightly curved, filled with alcohol; (2) bimetallic lamellæ thermometer of Teisserenc de Bort, strips of brass and steel, soldered together and bent into a circle; (3) tubular thermograph of Hergesell, German-silver tube on block of nickel steel; (4) bimetallic thermograph of Assmann, copper and nickel steel; (5) bimetallic thermograph of Kusnetzow, brass and nickel steel, bent to an S curve. The three first instruments could empirically be compared as they are often used simultaneously; (1) and (2) are in very good agreement; (3) generally marks 0·6° C. less than (2) and lower amplitudes at sudden changes (in inversion strata), although it is on the whole more sensitive than (2). In making the tests, the instruments are first warmed and then slowly cooled by means of an air-blast of constant temperature and velocity, with the aid of apparatus of Recknagel and of Krell. The inertia coefficient appears approximately to be inversely proportional to the square root of the velocity of ventilation. The mean error for pressure records seems to be ± 2 mm., for temperatures ± 2° C., so that the temperature gradients for strata of 1,000 m. thickness would be reliable within a few tenths of a degree. H. B.

951. *Stresses in Crane Hooks.* **J. Goodman.** (Inst. Civil Engin., Proc. 167. pp. 296–318, 1906–1907.)—The author describes experiments on the measurement of the strain of loaded crane hooks, and compares the results with Andrews' and Pearson's theory, and is in agreement with them in finding that the actual tensile stress is always materially greater, and the compressive stress less, than the ordinary simple theory indicates. On account of the great care needed in the application of Andrews' and Pearson's theory to design, the author gives empirical formulæ, which should be used in approximations, the result being afterwards checked by the accurate graphic method. Data of practicable sections, whose shape necessarily differs somewhat from the ideal, are given; the experiments were carried out on hooks of these sections. F. R.

952. *Horizontal Compression Members with Eccentric Pin Connections.* **J. E. Boyd.** (Eng. News, 57. p. 404, April 11, 1907. Paper read before the Amer. Assoc. for the Advancement of Science.)—The usual formula $e = wl^2/8P$, which makes the moment at the centre due to the weight equal to that due to the thrust, over-compensates at all other points. It is shown that $e = wl^2/10P$ gives a better distribution of compensation. e is the eccentricity of the pins, P the thrust, w the weight per inch, l the length. F. R.

953. *Stresses in Columns under Eccentric Load.* **O. H. Basquin.** (Eng. News, 57. pp. 420–422, April 18, 1907.)—The author endeavours to put the theoretical formulæ of Euler, &c., into the forms most suitable for tabulating numerical values for reference, or, better still, plotting curves. He gives examples of curves showing the value of the cosines in the Euler formula, showing the relation between load divided by area, ratio of length to least radius of gyration, maximum stress, and eccentricity of load, also between ultimate load and the corresponding quantities, in the cases of steel, timber, and cast-iron columns. In the case of cast-iron columns, taking E = 15,000,000 lbs. per sq. in., if the eccentricity is so small that the column can carry over 7,000 lbs. per sq. in., the compressive limit (taken at 20,000 lbs. per sq. in.) will be reached before the tensile limit. If the eccentricity be such that the column cannot carry so much as 7,000 lbs. per sq. in., then the tensile limit (taken at 6,000 lbs. per sq. in.) will first be reached. F. R.

954. *Design of Draw-press Tools.* **K. Musiol.** (Stahl u. Eisen, 27. pp. 477–482, April 3; 518–520, April 10, and pp. 551–558, April 17, 1907.)—By consideration of the change of shape of radial strips of the disc or cup to be drawn, the author arrives at formulæ relating the diameters of the disc or cup before and after each draw. With the further aid of numerous experimental results, a chart is prepared by a method described, from which it is possible to read off readily, for a disc or cup of given diameter and thickness of metal, which is to be drawn to a cup of given diameter, the number of passes required and the diameter to which it is to be drawn at each stage, and hence a preliminary estimate of the dimensions of the dies can be made. The final determination of the dimensions and curvatures of the dies is discussed. It is shown that the limiting radius of curvature for iron plates is 10 times the thickness δ, and for copper 5δ. The proper relation between the diameters of punch, d_1, and of die (matrix), d_2, is found to be $d_2 = d_1 + (3 \text{ to } 4)\delta$, for either cupping or drawing. F. R.

955. *Art of Cutting Metals.* (Amer. Soc. Mech. Engin., Proc. 28. pp. 1159–1179, March, and pp. 1339–1374, April, 1907. Discussion.) [For F. W. Taylor's paper see Abstract No. 369 (1907).]—**H. C. H. Carpenter** discusses chiefly the metallographic portion of the paper. He points out that some of the alloys with which he dealt showed critical evolutions of heat at temperatures affecting "red-hardness." He attempts to explain "red-hardness" as due to the partial change of structure from austenitic to martensitic, and states that chromium assists this change, hence giving the property to high tungsten steels which without Cr lack the property. This interpretation of the behaviour of Cr is unsupported, however, by experimental evidence. **J. E. Stead** states that steels which he has found give the best results contain C, 0·6 to 1·0; Cr, 2·5 to 3·5; and W, 11·0 to 18·0 per cent., and contributes the experience of **J. Key,** who found that increase of cutting speed beyond certain limits involved so great an expenditure of power as to be useless. **J. T. Nicolson** criticises at some length the author's statements, as regards such matters as cut, feed, and speed, and shows that some of the author's results are well in agreement with his own simpler approximate formulæ. In reply, the **Author** states that his complex formulæ, which include many more variables, are to be used only for slide-rule making. Whilst admitting the value of Carpenter's explanation, he is not satisfied that it is sufficient, as he has had tools of equal "red-hardness" showing a variety of structures and of hardness in the cold state. In reply to Stead and Key, he states that the trouble which comes from undue wear of lathe centres when cutting with high-speed steels can be obviated by making the centre of a high-speed steel properly treated. F. R.

956. *Hard Woods of Western Australia.* **G. A. Julius.** (Engineer, 103. pp. 277–280, March 22, 1907. From Western Australian Government Reports. Abstract.)—Gives results of cross-bending, tensile, end compression, cross-compression, shearing along grain, hardness in resistance to penetration, spike holding, moisture, and spalling (resistance to shocks such as are applied in pile-driving), tests of the various woods of Western Australia, together with a map showing the localities of their occurrence, and descriptions and illustrations of the apparatus used in the tests. Tate (*E. cornuta*), a wood as yet little known, gives as high as 17·5 tons per sq. in. tensile strength, and its weight is 79 lbs. per cub. ft. when freshly cut. F. R.

957. *Prevention of Freezing in Concrete by Calcium Chloride.* **R. K. Meade.** (Eng. Record, 55. pp. 501–502, April 20, 1907.)—The author's experiments show that concrete exposed to low temperatures (such as 20° or 30° F. below freezing) before setting, or alternately to low temperature and ordinary temperature has much greater strength if calcium chloride has been added to it. Two per cent. of the cement is a suitable quantity of calcium chloride to give best results, practically neutralising the effect of cold weather. Further, a block containing 2 per cent. $CaCl_2$ absorbed only half as much water as a similar block without $CaCl_2$, under similar conditions. Efflorescence is avoided if the chloride be mixed with the water. F. R.

958. *The Ether.* **O. J. Lodge.** (Nature, 75. pp. 519–522, March 28, 1907.)—On the basis of a consistent working hypothesis an attempt is made to estimate the absolute value of the ethereal constants. The material universe seems to consist of a perfectly continuous incompressible and inextensible medium filling all space without interstices, and as a whole completely at rest, and moreover frictionless. It possesses that property of "rigidity" characteristic of what is called a solid, this being produced within it by a state of excessively fine-grained turbulent motion. The elasticity is gyrostatic. The rigidity possessed by the ether may be called electromotive elasticity, identical with that of a dielectric—the property which causes recoil after charge—and it has been denoted by $4\pi/K$, where K is the absolute specific inductive capacity for free space. This shape-elasticity of the ether is accompanied by another property akin to inertia. To this magnetism is due, and it is denoted by $4\pi\mu$, where μ is the absolute magnetic permeability of free space. The ether may be said to have a certain density or mass per unit volume, and by reason of this and the electric elasticity transverse electromagnetic waves are transmitted through and by the ether at a perfectly definite and known speed. During the passage of waves the ethereal structure is sheared to and fro with equal opposite movement of two aspects, or elements, or conditions of its structure, such shear being equivalent to what is called electric displacement. If strained beyond a certain critical shear (of unknown value) a separation of the ether into two components would occur. One of these components is called positive, the other negative electricity. Once separated they do not re-form the original substance out of which they were produced. It is calculated that the density of the ether is of the order 10^{12} gm. per c.cm. The value of the constant K, Faraday's dielectric constant, for free space is approximately estimated to be 10^{-33} c.cm. per erg. Or the intrinsic energy of constitutional motion of the ether, to which its rigidity is due, is of the order 10^{33} ergs, or 10^{26} Joules per c.cm.—about 100 ft. lbs. per atomic volume, which is equivalent to the output of a million horse-power working for forty million years in every mm.^{3} of space, or the energy of a thousand tons per mm.^{3} moving with the velocity of light, the motion considered being internal and circulatory. The transmission of waves is next considered in the paper, and then the amplitude of light waves. Calculation of the amplitude of the shear corresponding to the most intense illumination gives 10^{-17} of a wave-length as the amplitude of the most intense visible light known. The maximum strain is 2π times this fraction, or comparable with 10^{17} dynes per sq. cm. or 10^{11} atmos. In considering the hypothesis of an ethereal flow along lines of magnetic induction the author mentions his experiments in 1893, when he carefully looked for some longitudinal flow along lines of magnetic force. A field of 1,400 c.g.s. units was applied over a length of light-path of about 14 m., and a drift of 1 ft. per sec., or about 10^{-9} of the velocity of light, could have been detected by the shift of micrometrically viewed interference bands, but no effect whatever was observed. Summing up: the behaviour of the ether indicates its possession of an immense elasticity or rigidity, 10^{33} dynes per sq. cm., combined with a property analogous to, and resulting in, material inertia, expressed by denoting the density of the ether as of the order 10^{12} gm. per c.cm. All stress must really exist in the ether. J. J. S.

959. *The Density of the Ether.* **O. J. Lodge.** (Phil. Mag. 13. pp. 488–506, April, 1907.)—The first part of this paper consists of the discussion of the nature and properties of the ether, and deals particularly with the

hypothesis, founded on various experimental facts, that the ether may be very dense. This reasoning has recently been given somewhat more fully by the author elsewhere [see preceding Abstract]. The estimates of the paper are: That the ether has a magnetic inertia-coefficient which can be represented by likening it to a mechanical medium with a density of 10^{12} gm. per c.cm.; that the intrinsic ethereal kinetic energy is 10^{33} ergs per cm.^3; and that any streaming along magnetic lines of force is, in cm. per sec., one four-millionth of the number of c.g.s. units of intensity in the magnetic field. The second part of the paper gives an account of an experimental attempt to observe the hypothetical magnetic ether drift. These experiments were made in the years 1892 and 1893. The paper is followed by appendices, in which quotations are given from earlier writers on the subject of a hypothetical magnetic flow, and remarks are made by Larmor on considerations respecting a rotationally elastic ether. In a recent note to the author J. J. Thomson says that he has held for some time the view that the mass of bodies is the mass of ether they carry along with them, and that this mass can be carried along by the lines of electric force as well as the bodies these lines connect. The amount carried by the small negative end is small compared with that carried by the lines of electric force, while the amount of the ether carried by the large positive end exceeds that carried by the lines, hence the mass of the corpuscle seems wholly electrical, while that of the atom does not. He considers, however, both masses are identical in origin, being masses of portions of ether. This supposition requires a very dense ether. J. J. S.

960. *Theory of the Brownian Movements.* **M. Smoluchowski.** (Acad. Sci. Cracovie, Bull. 7. pp. 577–602, July, 1906. Ann. d. Physik, 21. 4. pp. 756–780, Nov. 27, 1906.)—The generality and invariability of this phenomenon and its independence of external conditions point to its kinetic nature; observation shows that it is not due either to convection or capillarity, and it is much more probably the result of unbalanced collisions of the suspended particles with the molecules of the liquid in which they are. On the assumption that a particle's speed is practically constant, but that its direction is varied by the collisions, which are frequent, its mean free path is calculated to be $Ac/\sqrt{n}$, where c is the molecular speed in the liquid, n the collision-frequency, and A is $4\sqrt{2}/3$ or $\sqrt{(3/2)}$, according as the radius of the particle is small or large in respect of the free path. The independence of the motion on the nature and mass of the particles (*e.g.*, bubbles of gas and particles of heavy metals acquire speeds of the same order of magnitude), the increase of the speed as the size of the particles diminishes and as the temperature increases, and the smallness of the movements in viscous liquids, are thus deducible from the theory. The theory demands that there should be diffusion of the particles with these Brownian motions, and this is in agreement with observation. There is finally a slight discussion of the stability of media containing particles in this state.

R. E. B.

961. *Constitution of the Atom and Coulomb's Law.* **H. Pellat.** (Comptes Rendus, 144. pp. 480–482, March 4, and pp. 744–746, April 8, 1907.)—It is known that on the theory of the constitution of the atom, as developed by J. J. Thomson, Lorentz, Larmor and others, it consists of a central charge of positive electricity around which circulate the corpuscles negatively charged, the centripetal force being electric, the period of luminous vibration emitted by an atom of a gas being that of rotation of the corpuscle. Langevin has calculated the period for an atom of sodium and finds it to correspond to the ultra-violet. The present paper gives a calculation on the supposition that in the solid state the atoms are packed close together, and further that (1) the orbits are circular; (2) the atom is spherical, *i.e.*, the orbits of the corpuscles are oriented in all senses; (3) the law of Coulomb is applicable to these intra-atomic distances. He thus obtains as the maximum wave-length, due to the outer corpuscle, the expression $0{\cdot}000005218 \times \sqrt{A/D}$, where $A =$ atomic weight and $D =$ density. But this formula yields for sodium, zinc, iron, and copper respectively the following values of wave-length: 0·0000254, 0·0000157, 0·0000140, and 0·0000139. Thus the vapours of these metals should emit radiations far into the ultra-violet. As the result is in contradiction with the facts, it remains to examine the assumptions. As to the orbits being circular, this is regarded rather as an approximation than a rigid hypothesis. The author accordingly prefers to cast doubt upon the law of Coulomb for these distances or the spherical form of the atom, especially the latter. In the second paper the author examines if the form of the atom arrived at leads to stability and finds that a flat atom could not be stable. The stable quality of the atom is associated only with a form nearly spherical. The papers lead to the conclusion that the law of Coulomb ceases to be exact at very small distances of the order of intra-atomic distances; the attractive force should increase less rapidly than the inverse square of the distance, or the repulsive force more rapidly. **T. Tommasina** (Ibid. pp. 746–747).—A brief discussion on Pellat's article. E. H. B.

962. *Force exerted by Wind on a Vertical Vortex.* **B. Brunhes.** (Comptes Rendus, 144. pp. 900–902, April 29, 1907.)—The following law is formulated: "A horizontal current exerts upon a vertical vortex in left-handed motion a horizontal force normal to the air-current, and directed towards its left; the force is directed towards the right of the air-current if the vortex is right-handed." To prove this experimentally Weyher's apparatus is used, consisting of a wooden case with one glass partition, in the roof of which is mounted a drum kept in rotation by a small dynamo. The resulting vortex is rendered visible by a column of white smoke originating in a dish where hydrochloric acid and ammonia are mixed, and produce fumes of sal-ammoniac. A jet of air, with a speed of some 80 m. per sec., is generated by an electric fan and directed against the vortex. When the latter is 140 cm. high, and the drum rotates 1,000 times per sec., there is a displacement of about 2 cm. in the centre of the vortex, in the direction already indicated. By means of a small pressure probe, a corresponding displacement of the minimum of pressure can be demonstrated, as also the difference of pressure producing the lateral displacement. E. E. F.

963. *Atmospheric See-saw Phenomenon and Typhoons.* **W. Krebs.** (Nature, 75. p. 560, April 11, 1907.)—According to K. Seemann and G. Meyer there should be, especially in the months Sept. to Jan., low pressure at full moon and high pressure at the first quarter. This was so in Jan., 1907, when high pressure was observed over Northern, Central and Eastern Europe on Jan. 21, and low pressure on Jan. 29; by the following first quarter, on Feb. 20, the conditions were completely reversed, pressure being very low. Examining the data of the Meteorological Office, London, the author (of Hamburg) finds that the see-saw was general. The isobar of 760 mm. on Feb. 20 included the greater portion of Europe and North America—nearly one-tenth of the surface of the globe; but there

was a centre of very high pressure over the Transbaikal district: 789·8 mm. at Chita, 785 mm. at Nerchinsk, 788·4 mm. at Irkutsk. These values are probably too low, and on Jan. 22 and 23 pressures of more than 800 mm. were recorded in those districts. The high-pressure area of Jan. 22 and 23 covered one-third of the globe; Australia, South-West Asia and Africa were under low pressure. East of Japan and Formosa low pressure also prevailed on Jan. 23, and in Tierra del Fuego the barometer was at 750 mm. The areas in which typhoons are frequent seem to coincide with the areas of contrary see-saw. H. B.

964. *Salton Sea and the Rainfall of the South-Western United States.* **A. J. Henry.** (Monthly Weather Rev. 34. pp. 557–559, Dec., 1906.)—The depression of Salton (in the Colorado desert of Southern California) has in recent years received much water from the Colorado River, and it has been suggested that the thus created large Salton Sea was responsible for the increased rainfall of the South-Western States, especially of Arizona, whose rainfall of 1905 exceeded the normal (11·75 in.) by 14·85 in. The excessive rainfalls were in fact recorded in the whole of the Southern States, and they extended even up to South Dakota. A. P. Davis had already pointed out that the Gulf of California was much more likely to affect the rainfall of the South-Western States than Salton Sea, and the author further proves that the change in the humidity could not pass beyond the immediate confines of the Colorado Desert. H. B.

965. *The Belgian International Balloon Service.* (Nature, 75. pp. 572–573, April 11, 1907.)—Since March, 1906, monthly ascents have been made from Uccle on international days, and the results communicated by Lancaster to the Belgian Academy and to *Ciel et Terre.* Two rubber balloons, of diameters 1,900 and 1,350 mm. are coupled in tandem; the meteorograph, made by Bosch, of Strassburg, consists of Bourdon tube, two metallic thermometers (Hergesell and Teisserenc de Bort), and hair-hygrometer. The particulars given show that the inversion stratum lies between 10 and 15 km. and even higher; in one case an isothermal zone was found between 15,300 and 17,000 m., with a temperature of —62° C., while at the maximum height reached, 18,472 m., the temperature was —57·5° C. H. B.

966. *Temperature of the North Sea.* **D'A. W. Thompson.** (Nature, 76. pp. 43–45, May 9, 1907. Abstract from Second Report on Fishery and Hydrographical Investigations in the North Sea and adjacent Waters, 1904–1905.)—Observations of temperature and salinity are taken on the *Goldseeker* in various depths at some fifty stations, and reports are received from passenger liners. Temperatures alone are dealt with in this paper, which chiefly explains the methods of representing the results. For the temperatures along the line Leith-Hamburg, *e.g.*, the method of Lalanne is used. The ordinates are the months of 1905, the abscissæ the deg. of longitude, and the temperatures are marked on more or less horizontal lines, running across the diagram, the "isopleths." These curves show that there is little difference of temperature all the way in early summer and in late autumn; about March the sea becomes colder, and about Aug. hotter, as one travels eastward. The seasonal variations in temperature range from 6 to 13° C. near the Scottish coast, and from 4 to 17° C. near the German coast. The changes are slow in midwinter and summer and rapid in spring and autumn, and the fall is generally

slower than the rise. A diagram of this kind is also given for the depth of 100 m. on a line from Buchan Deep, near Aberdeen, to Viking Bank, between the Shetlands and Norway. H. R. Mill shows in his diagrams the changes at one point for all depths during successive months. Assuming that a sine curve approximately represents the actual succession of temperatures, the annual wave may be indicated by a circle on which the months and temperatures may be read. The centre of the circle is at a height above the base line corresponding to the mean temperature at the spot, and the radius is proportionate to the half range. H. B.

967. *Amount of Atmospheric Transport of Sea-salt.* **E. Dubois.** (Archiv. Musée Teyler, 10. pp. 461–471, 1907.)—At Land's End, south-westerly winds may carry 359 mgm. of sodium chloride per litre of rain; at the Helder, the rain contains up to 350 and 500 mgm., but the average is only 60 mgm. Further from the sea the proportion of sea-salt carried is much smaller; at Rothamsted it is 3·3 mgm./litre, at Cirencester 3·6 mgm. (the average for England is 3·6 mgm.); in Troy, New York, it is 2·7 mgm.; in Caen, Normandy, 5 mgm.; at Nantes, 14 mgm.; at Outucamund, India, 120 km. from the sea, 0·66 mgm. The amount of sea-salt carried decreases, as the last example suggests, with the elevation; on the Pic du Midi, 2,877 m., it is 0·34 mgm./litre. As these numbers differ too much, the author bases an estimate on the salt contained in the fresh water which infiltrates into the dunes near Scheveningen, as determined by lysimetrical methods. According to H. E. de Bruyn's observations, extending over eight years, the annual average of rain water which enters these dunes is 382 mm.; the dunes lie 1 m. below sea-level. The water supply of the Hague and of Amsterdam, which is taken from those dunes, contains 55 mgm. of salt per litre. The author shows that these figures really represent enormous quantities, about 6,000,000 kg. of salt being drawn from these 31,000 hectares of dunes. But the amount of dissolved calcium carbonate, brought by the Rhine across the Dutch frontier, is in the course of a year 6,600,000,000 kg. Taking the average of 60 mgm. of salt per litre of rain, the author further demonstrates that the salt of the Great Salt Lake in Utah could not have been of atmospheric origin, considering that the lake now covers only a tenth of the area of the hypothetical Lake Bonneville; there is far too much salt in the lake. H. B.

968. *Pulsations of the Earth and Krakatoa Eruption.* **H. Nagaoka.** (Physico-Mathematical Soc., Tokyo, Proc. 4. 2. pp. 35–43, March, 1907. Nature, 76. pp. 89–90, May 23, 1907.)—The vibrations of a homogeneous elastic sphere have been treated in their various aspects by Kelvin, Jaerisch, Lamb, Chree, Bromwich, Jeans, and others. The importance of considering the influence of gravity seems to have been recognised by Larmor, and at his suggestion the problem was solved for an incompressible homogeneous sphere by Bromwich. The term relating to the viscosity of the substance is still left out of account, and the compressibility of the substance would no doubt slightly modify the result. The effect of gravity on the vibrations of the sphere, in its application to the pulsation of the earth, cannot be neglected, as it affects the period of vibration in an appreciable manner. According to Kelvin, the tidal effective rigidity of the earth is about the same as that of steel, and a recent investigation by the present author points to a similar conclusion [see Abstract No. 1547 (1905)]. Using the transcendental equation of Bromwich for the spheroidal vibrations of a gravitating sphere, and taking the rigidity of the earth to be (1) that of steel, and (2)

that of glass, the first root of the equation gives values of 55 and 78 min. respectively for the period of the pulsation, the mean value being a period of 67 min. The effect of gravity is to reduce the period by a considerable amount; with the rigidity of steel, the free period is 66 min. without gravity instead of the 55 min. with gravity. The problem is whether any vibrations of the earth approximating to the values above cited have ever been observed or can be inferred from existing observations. The records of the gasometer at Batavia at the time of the eruption of Krakatoa are then analysed, and periods of 68·2, 66·7, 69, 67·3, and 60, with a mean of 67·2 min. are found. E. H. B.

969. *The Movement of Sand along the Sea-shore.* **Thoulet.** (Comptes Rendus, 144. pp. 938–940, April 29, 1907.)—Twenty-five years ago Renard showed that flint particles from the Normandy chalk had been found on the shores of Denmark, and Bréon has recently observed sand-grains from Brittany near Calais. Studying the phenomena in Brittany and Normandy, the author points out that the chief movements take place within the tidal shore range. The general direction of the movement is, in the Channel, eastward. But a sand-grain travels in zigzags, rolling up and down the beach with the breakers, of which there are from 12 to 18 per min.; each wave shifts the grain about 1 cm. parallel to the shore line, but the grain travels 8,000 times as far in being rolled up and down the beach. The wear by friction, although very slow under water, is thus considerable. Turning sharp-cornered particles of flint, quartz, magnetite, and other minerals in a drum filled with water, the author could not observe any wear under the microscope, nor any loss of weight after the particles had travelled 170 km. This transport of sand-grains in a zigzag seems to be the most important; direct transport by air and water currents and by ice, however, has also to be considered. H. B.

970. *Geological Applications of the Elastic Theory of Dislocations of the Earth's Crust.* **L. De Marchi.** (Accad. Lincei, Atti, 16. pp. 499–507, April 7, 1907.)—The author deals with certain practical applications of the theory of which in the former paper [Abstract No. 799 (1907)] he treated of the mathematics. The case, conceived in the former paper, of two parallel belts each in the plane of xy, and distant c from each other, one subjected to pressure and the other to elevating force, is shown to represent that of the degradation on the land side, and sedimentation on the ocean side, of a line of coast. On the surface there is on one side a synclinal, on the other an anticlinal formation, the axes of which coincide nearly with the lines of maximum degradation and maximum sedimentation. There is, in the zone of action, a translation of matter from the anticlinal to the synclinal. He discusses the asymmetrical character of mountain ranges, of which one side is usually much steeper than the other, *e.g.*, the Alps on the south side, the Andes on the west, &c., arguing against the views of Dana and Suess, that this asymmetrical formation is inconsistent with the theory of elevation. According to Suess, mountain chains are due to contraction of the earth's crust by cooling, which, he says, takes place sometimes predominantly in the vertical, sometimes in the horizontal direction, giving rise in the former case to steep inclination. According to the author the cooling of the earth's surface is much too slow to produce the results claimed for it by Suess. A special section is devoted to the consideration of the pre-Alpine regions of Italy, that is, the region beyond and to the south of the actual disturbance produced by the elevation of the chain of the

Alps. The characteristic of this region is the absence of horizontal displacement on the surface, while it increases with increasing depth, especially in the neighbourhood of the chain. The whole region is undergoing a slow elevation *en bloc* without disturbing the horizontality of the strata. In another section is discussed the effect of the intrusion of volcanic products. The conclusion at which he arrives is that the elastic theory agrees with facts better than either the dilatation theory of Mellard Reade or the contraction theory of Dana. [But if new mountain chains can only be formed, as appears by the present writer's treatment, by the crumbling down of older chains, must not the earth be tending gradually to a uniform dead level?] S. H. B.

971. *Vulcanism and its Causes.* **A. Brun.** (Archives des Sciences, 22. pp. 425–448, Nov., 1906.)—The author puts forward the suggestion that volcanic explosions have as their main cause the gases resulting from the dissociation of the salts, ammonium chloride and nitrate, of deep-seated origin. Aqueous vapour is considered to be of minor importance, the reaction, once started in the eruptive medium, proceeding as if the medium were anhydrous. L. H. W.

972. *On the Displacement which the Tide of the Adriatic can cause to the Instruments of the Astronomical Observatory of Padua.* **G. Zappa.** (Accad. Lincei, Atti, 16. pp. 625–632, April 21, 1907.)—The writer gives, on the authority of various observers, the mean height of the tides at four points on the Adriatic coast, namely, Venice, Grado, Porto Corsini, Trieste or Pola, all of which lie in direction roughly east of Padua. He calculates the volume of water due to the tide, the difference between mean high and low water within a polygon formed by seven points, whose distances from Padua are given in km., and the attraction which this body of water would exert at Padua, causing a periodic deviation of the plumb-line at that place, and so affecting observations of the meridian circle. He finds that these effects are not negligible. The general formula employed is $\tan a = [(1 - \lambda^2)/\pi E]F$, in which a is the required angle of deviation, F the attraction due to unit of mass at the point where a disturbing mass is situated, λ the coefficient of contraction, and E the modulus of elasticity. The values of λ are given in tables for various materials. S. H. B.

973. *Solar Eclipse, Jan.* 13, 1907. (Cosmos, 56. pp. 311–314, March 23, 1907. Nature, 75. p. 544, April 4, 1907. Abstract.)—The eclipse was observed as a partial one at the Zi-Ka-Wei Observatory, China, and determinations of terrestrial magnetism, temperature, and actinometric data were made during the progress of the phenomenon. The magnetographs showed nothing abnormal; the temperature and actinograph curves both indicated a decided decrease. The temperature began to fall about 15 min. after first contact, resuming its normal value about 27 min. after the maximum phase.
C. P. B.

974. *Ring of Minor Planets.* **P. Stroobant.** (Annales d'Observatoire Royal de Belgique, vol. 9, part 3, 1907. Nature, 76. p. 17, May 2, 1907. Abstract.)—Discussion of the constitution of the ring of minor planets, their relative distribution, masses, and classification with regard to their mean distance from the sun. A maximum occurs between the limits of 2·55 and 2·85 astronomical units from the sun, 199 of the asteroids considered being found to revolve within this annulus. It is further found that nearly all the

asteroidal matter is concentrated near to the middle of the ring in the neighbourhood of the mean solar distance of 2·7, and in general the smaller asteroids are relatively less numerous in the densest zones. C. P. B.

975. *Apioidal Binary Star-systems.* **A. W. Roberts.** (Brit. Assoc., Report, pp. 249–256, 1905.)—An examination of close binary systems has led the author to conclude that the density of all stars of this class is very small (average of six considered is 0·13 that of the sun); that all stars of this type are prolate in figure, the flattening depending upon the nearness of the stars; that the components move in almost circular orbits (eccentricity $< 0·1$; average of six is ¼ of this); that there is evidence of a rhythmical change of figure due to eccentricity of orbit. The case of β Lyræ is specially considered. L. H. W.

976. *Nebulous Groundwork in Taurus.* **E. E. Barnard.** (Astrophys. Journ. 25. pp. 218–225, April, 1907.)—In the course of an investigation into the nature of various dark rifts among the Milky Way stars, it was noticed that in many cases the rift appeared actually darker than the surrounding sky, and it was considered that this phenomenon might indicate the existence of a nebulous substratum in certain parts of the sky. They are specially well shown on plates taken of the region north and east of the Pleiades.

C. P. B.

977. *Spectrum of Mira Celi.* **V. M. Slipher.** (Astrophys. Journ. 25. pp. 235–236, April, 1907.)—From a photograph of the spectrum secured on Jan. 11, 1907 (reproduced in the paper), with the single prism spectrograph at the Lowell Observatory, it is noted that all the four hydrogen lines Hα, Hβ, Hγ, and Hδ are bright, their intensities increasing from the red to the violet. The series of absorption bands begins at λ4584, and extends to the red end of the spectrum. The prominence of vanadium absorption in this star is indicated by the close agreement between the group of strong comparison lines near λ4400 and the dark lines in the star. [See Abstracts Nos. 598 and 805 (1907).] C. P. B.

978. *Brightness of Sky near Sun's Limb.* **Ceraski.** (Astronom. Nachr., No. 4164. Nature, 75. p. 569, April 11, 1907. Abstract.)—From determinations in Nov., 1906, of the relative brightness of the sun's limb and the sky just outside it, the value of the ratio is found to be from 31·4 to 38·4—much lower than was expected. C. P. B.

979. *Europium in Stars.* **J. Lunt.** (Roy. Soc., Proc. Ser. A. 79. pp. 118–125, April 24, 1907.)—In measures of the radial velocity of α Boötis and β Geminorum the results for the calcium line at λ4435·851 were found to be discordant, in both stars the value coming out too low. In α Boötis the mean discordance was determined to be —3·28 km. per sec., indicating that this line appeared to be 0·049λ to the violet side of its tabular position. In β Geminorum the similar quantities were —2·71 km. per sec. and 0·040λ. Moreover, this discordance was not remarked in a true solar star such as α_2 Centauri, and in the above two stars the stellar line is stronger than the corresponding solar line. These considerations led to the assumption that some line of unknown origin was blended with the calcium line in these stars, and a line of europium at λ4435·75 appeared likely to be the one in

question. From the known behaviour of other allied elements it is suggested that if the lines of europium are so much more pronounced in the spectra of the more advanced solar stars, such as α Boötis, than in the solar stars proper, the rare-earth metals as a group may possibly account for many of the striking differences to be observed between them. C. P. B.

REFERENCES.

980. *The Crooked Bar on Elastic Supports, with Longitudinal Loading.* **H. Zimmermann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 18. pp. 326–338, 1907.)—Considers the same case as in Abstract No. 809 (1907), except that the member consists of several straight portions not in one straight line, but end to end, there being a support at each change of direction; as, *e.g.*, the upper member of a bow-string girder. F. R.

981. *Fatigue and Rate of Change of Section.* **T. E. Stanton.** (Engineering, 83. p. 505, April 19, 1907.)—Further discussion of this point referred to in Abstract No. 373 (1907), with photomicrographs and curves of results. F. R.

982. *Flow of Water over a Weir.* **J. Boussinesq.** (Comptes Rendus, 144. pp. 668–671, March 25, 1907.)—This paper gives an approximate theory of the flow of water in a thin layer over a vertical weir and without lateral contraction. The results agree with the experimental work of Bazin. A. W.

983. *Problems in Physical Limnology.* **A. Wœikof.** (Archives des Sciences, 21. pp. 392–411, 1906.)—The author discusses a number of questions which it is considered are those whose solution will tend to advance the science of limnology. These are: Limiting distinction between a lake with an outlet and a river; Geographic density of lakes; Shallowness of salt-water lakes; Fresh- and salt-water lakes; Influence of climate on thermal conditions of lakes; Air temperature over lakes. L. H. W.

984. *The Earthquakes of April* 15, 18, 19, 1907, *as recorded at Paris.* **G. Bigourdan.** (Comptes Rendus, 144. pp. 823–824, April 22, 1907.)—The Milne seismograph with two pendulums gave good records of the earthquake of April 15; the preliminary tremors point to an epicentre at 8,500 or 9,000 km. from Paris, which is the distance Paris–Mexico, measured on a great circle. The records of April 18 and 19 are less clear. H. B.

985. *Propagation of Earthquake Shocks within the Earth.* **G. Herglotz.** (Phys. Zeitschr. 8. pp. 145–147, March 1, 1907.)—By use of a method given by Abel, the equation from which, by indirect methods, Benndorf [Abstract No. 383 (1907)] deduced the velocity of propagation of earthquake shocks at different depths within the earth, is transformed so as to make the calculation more simple. R. E. B.

986. *Comet Giacobini* (1907*a*). **E. Esclangon, Rambaud, Sy, P. Brück, P. Chofardet,** and **Giacobini.** (Comptes Rendus, 144. pp. 611–615, March 18, 1907.)—Observations, calculated elements, and approximate ephemeris.

987. *The Cluster of Coma Berenices.* **E. Fagerholm.** (Ark. för Mat. Astron. och Fysik, Stockholm, 2. Parts 3 and 4. No. 31. pp. 1–30, 1905–1906.)—Photographic measurement of the principal stars and determination of their proper motion.

988. *Orbit of Comet* 1886 VIII. (Barnard). **E. Fagerholm.** (Ark. för Mat. Astron. och Fysik, Stockholm, 2. Parts 3 and 4. No. 19. pp. 1–22, 1905–1906.)

LIGHT.

989. *Apparatus for Photographic Photometry.* (Soc. Franç. de Photographie, Bull. 22. pp. 471–478, Dec. 1, 1906. Zeitschr. Instrumentenk. 27. pp. 183–185, April, 1907.)—An apparatus designed by H. Cousins and constructed by H. Bellieni to compare the photographic intensities of two sources by allowing them to act on two plates for different lengths of time, the exposures being graded over each plate by means of rotating discs similar to those in Scheiner's sensito-meter (Zeitschr. Instrumentenk. p. 201, 1894.) The two rotating discs are placed 1·5 mm. in front of the plates in two cameras, and have windows the boundaries of which are two concentric circles, one radius and a curve such that the time of exposure at any point is doubled by displacing the axis of the disc 1 cm. in the proper direction; the discs are electrically driven. After exposure and development, the plates have densities increasing from one edge inwards. To compare intensities, the two plates are cut along a radius through the middle of the exposed portions, and the two parts are brought together along the cut edges until points of equal density are opposite one another. The distance between the circular edges of the exposed portions then gives the ratio of the intensities, *e.g.*, 3 cm. displacement corresponds to the ratio $1/2^3$. G. E. A.

990. *The Isostigmar Lens.* **H. C. Beck** and **C. Beck.** (Photographic Journ. 47. pp. 191–199; Discussion, pp. 199–204, April, 1907.)—Description of a new type of photographic lens in which there is absence of astigmatism and good correction of the oblique spherical aberrations, the lens giving an image with very slight curvature. The discussion dealt mostly with the Petzval condition, the equation for which, **F. Cheshire** pointed out, does not give the curvature of the image surface over an extended area, as had been assumed, but at the vertex only. G. E. A.

991. *Glass Transparent to Rays of Short Wave-length.* (Nature, 75. p. 614, April 25, 1907.)—Messrs. F. A. and C. L. Lindemann, of Darmstadt, have made a new glass which is transparent to rays of very short wave-length. The substance lithium borate, $Li_2B_4O_7$, when fused produces a clear glass which shows no appreciable absorption in the ultra-violet spectrum above 2,000 A.U., the Al line 1856 being distinctly visible. The glass has the refractive index 1·5389 for the D-line, and is extremely transparent to Röntgen rays; also its dispersion towards the red side of the spectrum is fairly large; its specific gravity is 2·2, its hardness 6, and cubical expansion coefficient 118×10^{-7}. G. E. A.

992. *Doppler-effect and Electron Theory.* **G. A. Schott.** (Phys. Zeitschr. 8. pp. 292–293, May 1, 1907. Phys. Inst., Bonn, March 15, 1907. Écl. Électr. 51. pp. 340–342, June 8, 1907.)—The discovery of the Doppler-effect in canal rays has placed at hand the possibility of investigating a series of new problems, concerning the effect, if any, of the motion on the constitution of an incandescent body. It is pointed out that an error may be made in ignoring the above-mentioned possible effect and assuming the speed of a luminous particle as ascertainable from the ordinary theory of the Doppler-effect. It is shown that according to which of the several theories is adopted a different effect is to be anticipated. Thus, let the observations be made exactly transverse to the direction of motion, where the ordinary Doppler-effect fails. Then (1) on the relative theory of Bucherer no displacement is to be looked for ; (2) on the theory of Einstein, that time and length units are both changed by the motion, we should have a displacement towards the red measured by $\frac{1}{2}\beta^2\lambda_0$, where β = speed of motion divided by that of light ; (3) on the deformations theory of Lorentz (or that of Bucherer) we should have a displacement towards the red of the second order, whose exact value would depend upon the orientation of the analyser with respect to the direction of motion. [See also Abstracts Nos. 1382 and 1481 (1904), 2277 (1905), 174, 1749 (1906), and 1048 (1907).] E. H. B.

993. *Reflection from Transparent Substances.* **R. C. Maclaurin.** (Roy. Soc., Proc. Ser. A. 79. pp. 18–30, March 12, 1907.)—A careful comparison of theory with experiment as regards the intensity of reflection would seem to suggest itself as a crucial test of the validity of any optical theory. In spite of this, it was not till 1870 that Rood turned his attention to the subject with the view of testing Fresnel's laws, and concluded from his experiments that the reflecting power of glass conforms in the closest manner to the predictions of theory. But in 1886 Rayleigh showed this conclusion to be untenable. The difficulties of measuring the intensity of the reflected light accurately are very considerable, and Rood had contented himself with estimating the transmitted light and deducing the amount that was reflected. Rayleigh showed that when this fact was considered the difference between Fresnel's formula and Rood's experimental results might amount to 7 per cent. of the reflected light. Rayleigh found from his own experiments that recently-polished glass has a reflecting power differing not more than 1 or 2 per cent. from Fresnel's formula, but that after some months or years the reflection may fall off 10 per cent. or more, and that without any apparent tarnish. J. Conroy's results published in 1888 confirm those of Rayleigh. The present paper treats the subject mathematically on the hypothesis of a transition layer on the surface of the transparent substance. The results of this theory are given in tables and exhibited as graphs, the agreement with Conroy's results being very close. E. H. B.

994. *Astronomical Refraction.* **H. G. van de Sande Bakhuyzen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 587–599, Feb. 6, 1907. Proc., 9. pp. 578–589, Feb. 21, 1907.)—An investigation of the theory of refraction, in the course of which all recent determinations of the vertical distribution of temperature by means of balloons and kites have been given full consideration. Only the registrations giving records of 5,000 m. and higher are taken as showing complete data. The data have been divided into two classes according as the sky was clear or only partly clouded, and overcast. Tables are given showing the newly determined constants corrected for heights up to 18 km., the refraction of any atmosphere beyond this distance being neglected. C. P. B.

995. *Refraction in Compound Gases.* **J. Amar.** (Comptes Rendus, 144. pp. 260–261, Feb. 4, 1907.)—The refractive index of a compound gas may be determined by calculation from the "atomic refractivities" of its constituents. The refractivity is the refractive index less unity, and the atomic refractivity is the refractivity divided by the atomic weight. The refractivity of a com-

pound gas is obtained by summing up the products *ar* of the number of atoms *a* of each element in the molecule and the atomic refractivity *r* of such element: $R = \Sigma ar$. The author gives the following table of values of R calculated and observed:—

	Calculated.	Observed.
HCl	$453·5 \times 10^{-6}$	447×10^{-6}
NO	285·5 „	297 „
NH_3	358·5 „	371 „
H_2O	274 „	257 „

Conversely, the atomic refractivities of some substances may be found from the refractivities of their compounds. That of carbon is 186 millionths, and that of sulphur 415. Rouvier's value 1,629, obtained for sulphur vapour, indicates a tetratomic molecule S_4. The refractive index of ozone should be 1·000406. In liquids, the refractivity should be proportional to the square root of the mean atomic weight. E. E. F.

996. *Refraction of Compounds.* **J. Amar.** (Comptes Rendus, 144. pp. 482–485, March 4, 1907.)—The formula $R = \Sigma ar$ [see preceding Abstract] leads to another conclusion: Writing $R = A\Sigma r$, A represents the mass of the molecule. If the latter changes from one state of aggregation to another, it condenses *c* times to pass into the liquid state, and *c'* times to pass into the solid state. The refractivities, depending only upon the mass, will therefore be: $R_g = A\Sigma r$, $R_l = cA\Sigma r$, $R_s = c'A\Sigma r$. But these molecular masses A, *c*A, and *c'*A are proportional to the densities, and hence the refractivity is a continuous function of the density. In SO_2, *c* is 490, in CO_2 485, and in water *c'* is 1,140. Instead of the refractivities, the dielectric constants of elements and compounds may be calculated by Maxwell's relation $R = \sqrt{K} - 1$. Or R may be calculated from the known dielectric constant. Thus we get for carbon $R = 217 \times 10^{-6}$. The dielectric constant for liquid oxygen, deduced from the refractivity, is 1·45, and that for water is 1·8. E. E. F.

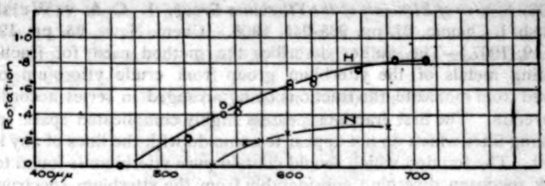
997. *Refractive Indices of Gaseous Potassium, Zinc, Cadmium, Mercury, Arsenic, Selenium, and Tellurium.* **C. Cuthbertson** and **E. P. Metcalfe.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 135–148, Feb. 27, 1907. Roy. Soc., Proc. Ser. A. 79. pp. 202–203, May 14, 1907. Abstract.)—A continuation of the investigation into the refractivities of the elements [see Abstracts Nos. 337 and 2175 (1905)]. In the present research, owing to the necessarily high temperatures, silica tubes were substituted for those of glass previously used, with the result that certain other improvements could be effected in the furnace and in the method of working. Metallic potassium was first tried, but it was found impossible to obtain a sufficiently dense vapour for a quantitative determination of the absolute index, owing to the chemical action of the vapour upon the silica. It was found, however, that the index must be less than unity between $\lambda = 6562$ and $\lambda = 5460$. In the case of the other six elements, tables are given containing the various observations for $\lambda\lambda = 6562$, 5893, 5460, and 5183. In the latter part of the paper the authors discuss all the values they have obtained for the elements and the bearing these have upon the periodic classification. They give the periodic table in a somewhat modified form, and so arranged that those elements with the same factors in the geometrical progression of refractivities are placed in the same horizontal row. The resulting arrangement is very suggestive as regards the basis of the periodic classification. E. C. C. B.

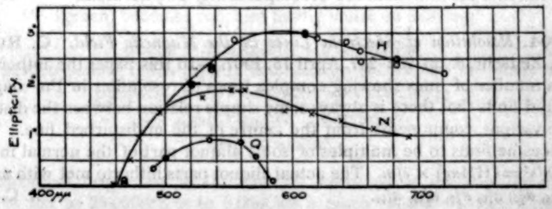
998. *Distortion Error of Photographic Objectives.* **E. Wandersleb.** (Zeitschr. Instrumentenk. 27. pp. 33–37, Feb.; and pp. 75–85, March, 1907.)—A theoretical and to some extent historical review of the above question, together with a graphic representation of the distortion present in sixty-four different photographic systems, of which particulars are given. For the case of a distant object the majority of the rapid symmetrical objectives exhibit noticeable deviations from orthoscopy, whereas several rapid unsymmetrical objectives possess very perfect orthoscopy. Distortion depends not only on the so-called tangent condition for the extreme rays, but also on the spherical aberration of the same rays. In consequence, the constructor can only eliminate distortion for a given size of picture and angle of view; when these latter change distortion appears, and is, in general greater, the larger the relative aperture of the objective. The curves are grouped under portrait, universal, wide-angle, and landscape objectives. G. E. A.

999. *Sensitometry of Photographic Plates.* **R. J. Wallace.** (Astrophys. Journ. 25. pp. 116–150, March, 1907.)—In advocating the use of spectrum testing in place of the use of coloured glasses or papers, the methods of analysis are briefly outlined. With prismatic instruments the most serious error arises from the absorption of the glass. The diffraction grating is from many standpoints more convenient and accurate, and for general plate testing the celluloid replicas are recommended, to use which a simple spectroscope is described and illustrated. A modified form of Brace's spectrophotometer is also described, which is considered specially suitable for measuring photographic densities. Regarding the light-source to be used, the author, after an extensive series of comparative tests of artificial illuminants, concludes that daylight from a low angle, when properly diffused, is a sufficiently reliable guide for practical tests in selective sensitiveness. Detailed instructions are then given for the comparison of plate speeds, employing the Hurter and Driffield *development factor,* and the quantitative estimation of colour from the resulting spectrum. [See Abstracts Nos. 112 (1906) and 48 (1907).] C. P. B.

1000. *Anomalous Dispersion and Ionisation.* **R. W. Wood.** (Nature, 75. p. 588, April 18, 1907.)—The author states that a previous criticism which he made concerning G. A. Schott's experiment on anomalous dispersion and ionisation is due to a misunderstanding [see Abstract No. 629 (1907)]. He also gives an account of the behaviour of sodium vapour in highly exhausted tubes. The vapour coming from the heated sodium has considerable "optical" density, and since it diffuses but slowly through the surrounding hydrogen, there exist layers of gas in the tube, in which the percentage of sodium vapour diminishes from the bottom of the tube to the top, enabling a considerable dispersion to be obtained. If no hydrogen were present, the sodium vapour would be evenly distributed and no dispersion would be obtainable. The author has found, in long steel tubes, that the density of the sodium vapour is increased by the presence of a gas which hinders the process of diffusion. S. G. S.

1001. *Rotation and Elliptic Polarisation by Iron Films.* **W. D. Harris.** (Phys. Rev. 24. pp. 337–348, April, 1907. Paper read before joint meeting of the Amer. Phys. Soc. and the Amer. Assoc. for Advancement of Science.)—Righi discovered that plane-polarised light passing through metallic films in the direction of a magnetic field is accompanied by a small ellipticity in the transmitted ray; Cotton measured a similar effect in certain optically active solutions, the work being extended by McDowell [Abstract No. 1202 (1905)]. The present work deals with the film effect as influenced by wave-length and field strength, tests being made on films of iron, nickel, and cobalt deposited in hydrogen, nitrogen, and oxygen, since there were indications that the presence of absorbed gases materially changed the magnitude of the effect. The apparatus used was a Brace half-shade elliptic polariser and compensator. Two sets of curves are reproduced as an example of the results obtained. The upper shows the rotation of the plane of polarisation plotted with wave-length for iron films deposited in hydrogen and nitrogen, the lower the amount of elliptic polarisation produced in terms of the rotation of the compensator. The field strengths employed were for the hydrogen film, 7,000 c.g.s., and for the films deposited in nitrogen and oxygen 12,000. No rotation was observed with films deposited in oxygen; a measurable ellipticity was present, however. With the passage of time, the qualities of the hydrogen film approach those of the nitrogen and oxygen films. With magnetic fields of different strength the ellipticity produced on a wave-length of $548\,\mu\mu$ is proportional to the field strength up to 7,000 c.g.s.; beyond this the rate of increase is very small. Under the best working conditions no ellipticity was observed for films of nickel and cobalt, nor could any be found in the reflected ray. It is therefore concluded that the ellipticity of the transmitted ray arises from unequal absorption of its two circular components.





G. E. A.

1002. *Fluorescent and Absorption Spectra of Anthracene and Phenanthrene Vapours.* **T. S. Elston.** (Astrophys. Journ. 25. pp. 155–169, April, 1907.)—The author has examined the fluorescent spectrum of anthracene vapour as obtained by passing a powerful beam of light through a bulb containing the vapour and by directing the spectroscope obliquely on to the fluorescent cone of light thus obtained. He finds three bands in this spectrum at $\lambda = 3900$, $\lambda = 4150$, and $\lambda = 4320$, superposed upon a continuous background extending from $\lambda = 3650$ to $\lambda = 4700$. He has also observed the limit of absorption of light by the vapour, and finds that it begins at about $\lambda = 4000$. The influence of admixture with other gases has been observed; the presence of inert gases does not affect the fluorescence as long as the pressure is below 1 atmo. Such gases as O_2, Cl_2, and SO_2, which at high temperatures react chemically with anthracene, almost completely extinguish the fluorescence at ordinary pressures. The fluorescence is excited by light located anywhere within the region of absorption by the vapour. There is, further, a close connection between the fluorescence of phenanthrene and anthracene vapours.

E. C. C. B.

1003. *Spectra of Elements of the Ytterbium Group.* I. **C. A. v. Welsbach.** (Monatsh. f. Chemie, 27. pp. 935–945, 1906. Chem. News, 95. pp. 196–199, April 19, 1907.)—The author describes the method used for fractionally separating metals of the ytterbium group from crude ytterbium oxalate prepared from monazite, the fractions being arranged in series according to their spectra. The first fractions possess highly complicated spark spectra, containing lines which do not appear to coincide with the lines of any known element. The fraction which should contain pure ytterbium is found to have a spark spectrum diverging considerably from the ytterbium spectrum, this being the first indication of the decomposability of ytterbium. T. H. P.

1004. *Resolution of Spectrum Lines in the Magnetic Field.* **C. Runge.** (Phys. Zeitschr. 8. pp. 232–237, April 15, 1907.)—In this paper the author deals with a number of lines showing complex types of resolution in the magnetic field, and finds that there is always some simple relation between the distances of the various components from the centre of the undisturbed line. These distances he finds to be multiples of some aliquot part of the normal interval $a = d\lambda/\lambda^2 = (H/4\pi c) \times e/m$. The actual aliquot parts hitherto met with are $a/_2$, $a/_3$, $a/_4$, $a/_5$, $a/_6$, $a/_7$, $a/_{11}$, $a/_{12}$. E. C. C. B.

1005. *Doppler-effect in Canal Rays.* **J. Stark.** (Astrophys. Journ. 25. pp. 230–234, April, 1907.)—In answer to a former paper by Hull [Abstract No. 638 (1907)] stating that the polarisation in the line spectrum of rapid canal rays observed by Stark [Abstract No. 885 (1906)] could not be detected, Stark now gives further details of the observations. It is not necessary for the detection of the Doppler-effect in the canal rays to employ a large spectroscopic dispersion, but the electric conditions must be such as to ensure that the kathode-drop shall not be less than a certain value. When the line spectrum of the canal rays has been photographed in the direction of translation, both stationary and movable lines have been found, and possibly Hull has only compared the stationary lines with the standard of the vacuum tube. [See also Abstract No. 57 (1907).]—**G. F. Hull.** (Ibid. pp. 234–235.)—Replying to the above criticism, Hull states that no polarisation was detected if care was taken to eliminate effects of strained glass tube and reflections from glass surfaces. With regard to Stark's suggestion of "minimum kathode-drop," he does not consider this the cause of absence of Doppler-effect in the case of mercury or helium, as the same conditions show it in hydrogen.

C. P. B.

1006. *Phosphorescence of Rare Earths.* **J. de Kowalski and C. Garnier.** (Comptes Rendus, 144. pp. 836–839, April 22, 1907.)—The rare earths are excellent "luminophores" [see Abstract No. 888 (1907)], and when mixed with effective "electronogens" they yield phosphorescent bodies of great intensity and stability. Such phosphorescent bodies are prepared as follows: A pure alkaline earth carbonate is dissolved in nitric acid, a very dilute solution of a nitrate of a rare earth is added drop by drop, and the whole is precipitated by means of ammonium carbonate. The carbonate thus obtained is mixed with a certain quantity of sulphur; the crucible is heated and plunged red-hot into melting ice, thus yielding a supersaturated solid solution. Even without a rare earth, the sulphide possesses some phosphorescence, probably due to traces of copper. In practice the authors always heated the sulphide for 10 min. with one of the following fluxes: Na_2SO_4, K_2SO_4, $Na_2B_4O_7$, Na_2HPO_4, NaFl, KCl, KFl, $MgCl_2$, $MgCl_2$, the fluorides being particularly effective with samarium. Various preparations were tested with the ultra-violet light of a mercury lamp. The authors used the following formulæ, where the figures denote grammes:—

$$0{\cdot}5CaS + 0{\cdot}02K_2SO_4 + 0{\cdot}0002Pr$$
(durable pink phosphorescence);

$$0{\cdot}5CaS + 0{\cdot}02Na_2SO_4 + 0{\cdot}0002Pr$$
(green, becomes red at 200°);

$$0{\cdot}5CaS + 0{\cdot}02Na_2SO_4 + 0{\cdot}0002Nd$$
(green, becomes red, and finally violet on heating);

$$0{\cdot}5SrS + 0{\cdot}02Na_2SO_4 + 0{\cdot}000042Sm$$
(vivid golden-yellow, fades rapidly into orange, shows two red lines and a yellowish-green line in the spectroscope);

$$1SrS + 0{\cdot}015Na_2SO_4 + 0{\cdot}000018Er$$
(lemon-yellow).

The maximum brightness in the case of samarium is obtained by adding 1 part of Sm to 25,000SrS or to 6,000CaS, a much higher dilution than that which gives to maximum luminosity under kathode rays. E. E. F.

1007. *Transmission of Röntgen Rays through Metallic Sheets.* **J. M. Adams.** (Amer. Acad., Proc. 42. No. 26. pp. 671–697, April, 1907. Amer. Journ. Sci. 23. pp. 375–378, May, 1907. Abstract. Contribution from the Jefferson Physical Laboratory.)—The rays are allowed to fall on a thin sheet of platinum attached to a copper-constantan couple, the arrangement forming a radio-micrometer. Screens of the various metals can be interposed, and the absorption can then be obtained. The instrument can also be calibrated absolutely by the radiation from a black body, using Kurlbaum's results for the total net radiation of such a body. If also the absorption by the metal screen be assumed to follow an exponential law, then $a = e^{-kd}$, where a = fraction of radiation which the screen absorbs, and d = screen thickness; a and d are measured, hence k is found. The fraction of the radiation absorbed by the instrument can therefore be calculated if the metal for screen and instrument is the same, and hence the energy of the rays measured absolutely. This is found to be 0·00325 gm.-cal. per sec. The rays are transmitted by a metal equally well whether it forms a solid mass or is laminated. The probability that a ray is transformed into one of another kind by transmission is small. The absorption is independent of the intensity of the rays, provided they remain of the same kind. Except in the case of aluminium-silver the order in which the rays pass through the metals has no influence on the absorption. R. S. W.

1008. *Impulse Breadth of Röntgen Rays.* **W. Wien.** (Ann. d. Physik, 22. 4. pp. 793–797, April 4, 1907.)—A much smaller value has been found by the present author for the impulse breadth (*Impulsbreite*) of Röntgen rays than that found by Haga and Wind. Van der Waals, Jr., has sought to harmonise the two lines of reasoning by another consideration. But Wien here discusses the matter and concludes by asserting that as a necessary consequence of the Stokes-Wiechert hypothesis he is led to a much smaller wave-length for the Röntgen rays than that found by Haga and Wind. [See also Abstracts Nos. 348 (1906) and 852 (1907).] E. H. B.

1009. *New Intermediate Thorium Product.* **O. Hahn.** (Phys. Zeitschr. 8. pp. 277–281, May 1, 1907. Chem. Inst. d. Univ., Berlin, March 22, 1907. Écl. Electr. 51. pp. 271–278, May 25, 1907.)—Boltwood and Dadourian have found that the activity of commercial thorium nitrate is about half what it should be according to its content of thorium oxide. [Abstracts Nos. 1386 and 1388 (1906).] The author has therefore tested at what stage in the commercial purification the radio-thorium is removed. A large number of samples have been tested, but no sudden decrease in activity is found. Boltwood, working with α-rays, has found that thorium nitrate whose activity has been largely removed remains in this inactive condition for at least two years. On the other hand, the author working with β-rays has proved beyond doubt that radio-thorium decreases appreciably in activity. He therefore concludes that there is a product intermediate between thorium and radio-thorium which does not emit α-rays. From tests on commercial samples of different ages reckoned from their purification, he finds that the activity decreases for three years, then remains constant for some time, and finally increases again, showing the presence of this new product. The life of the substance must be long. R. S. W.

REFERENCES.

1010. *Suspended Collimator for Zenith Determination.* **G. Lippmann.** (Comptes Rendus, 144. pp. 873–874, April 29, 1907.)—The instrument is intended for rendering the geometrical position of the zenith at any station visible in the field of a telescope as a small luminous point. Provision is made for reversal of the instrument to eliminate error of setting. Steadiness is secured by an attached system of vanes suspended in oil, and the whole is hung from a steel ribbon. C. P. B.

1011. *Radau's Theory of Refraction.* **L. de Ball.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1363–1422, Nov., 1906.)—Fairly complete discussion of the application of Radau's method to the reduction of refraction constants. C. P. B.

1012. *Wave-length Tables of the Spectra of Neon, Krypton, and Xenon.* (Brit. Assoc., Report, pp. 105–153, 1905. Report of B.A. Committee.)—Tabulated wave-lengths, intensities, and oscillation frequencies *in vacuo* of the spectrum of neon and of the two spectra of krypton and xenon obtained (1) without, and (2) with Leyden jar and spark-gap. L. H. W.

1013. *Structure of some of the Spectrum Lines of Mercury.* **B. Galitzine.** (Acad. Sci. St. Pétersbourg, Bull. 6. pp. 159–168, April 1, 1907.)—Some measurements of the components of the following lines in the spectrum of mercury: $\lambda = 5791$, $\lambda = 5770$, $\lambda = 5461$, $\lambda = 4358$. The observations were made with an echelon grating, and with both a vacuum tube and an Arons lamp. E. C. C. B.

HEAT.

1014. *Correction of Thermometer Readings.* **J. Adam.** (Zeitschr. Instrumentenk. 27. pp. 101–104, April, 1907.)—An improvement is described of Mahlke's improved auxiliary thermometer [see Physical Soc. Abstracts, No. 148 (1895)] for determining the mean temperature of the mercury in the unimmersed part of the stem of a thermometer is here described; also a correction of Mahlke's formula is given, which should be $c=(T'-t)r/(m+t-r)$, where T′ is the apparent temperature given by the thermometer, r the number of unimmersed divisions, t the mean temperature of the mercury occupying them, and $1/m$ the apparent expansibility of mercury in glass.

R. E. B.

1015. *Recording Calorimeter for Explosions.* **B. Hopkinson.** (Roy. Soc., Proc. Ser. A. 79. pp. 138–154, April 24, 1907. Bull. Soc. d'Encouragement, 109. pp. 597–604, May, 1907.)—The explosion vessel consists of a cast-iron cylinder 1 ft. long and 1 ft. in diam., with end plates bolted on; the cylinder is lined with wood ¼ in. thick and the end plates with cork; copper strip, ¼ in. wide and 0·04 in. thick is wound on the inside of the cylinder with a clearance of 0·05 in. between successive turns, and the end plates are similarly covered with it. The varying temperature of the chamber during an explosion is estimated from the varying resistance of the strip which is deduced from the varying deflections, photographically recorded, of a galvanometer needle. In the estimation of the heat produced allowance has to be made for the heat which passes through the strip to the wooden backing and for that which goes directly to the uncovered area of the cylinder: the latter is somewhat uncertain, but the former is pretty accurately determined by comparison of the effects on the strip when fully exposed to the air and when in contact with the backing. A detailed discussion of the law of heat loss is given.

R. E B.

1016. *Hydraulic Analogy of Radiating Bodies.* **R. W. Wood.** (Nature, 75. pp. 558–559, April 11, 1907. Phys. Rev. 24. pp. 436–440, May, 1907.)—The device described serves as a class illustration of the varying behaviour of different types of radiating bodies when introduced into a flame, especially that of the modern incandescent mantles used in gas-lighting. The radiator is represented by a tall, hollow cylinder open at the top and closed at the bottom, provided with a number of outflow pipes of different sizes. Water flows into the cylinder at a certain definite rate from a horizontal pipe the height of which above the base of the cylinder represents the temperature of the flame. The height at which the water stands in the cylinder when the inflow equals the outflow at the lower pipes represents the temperature which the radiator acquires in the flame. The jets of water which issue from the tubes represent radiation of different wave-lengths, the small jets representing the short waves. The case of a black body is illustrated when all the bottom pipes are wide open. By blocking some of the pipes in various ways different types of radiation may be illustrated. The model with all its tubes plugged with cotton represents the mantle of pure thoria, while the case of the Welsbach mantle is shown by pulling out the porous plugs from some of the smaller tubes. In this case the water will rise to a great height in the cylinder and powerful jets will issue from the small tubes.

J. J. S.

1017. *Convective Equilibrium of a Spherical Mass of Gravitating Gas.* **J. Prescott.** (Phil. Mag. 13. pp. 459–467, April, 1907.)—By general physical considerations and mathematical analysis the author attacks the problem of the equilibrium of a mass of gas subject only to the mutual gravitation of its parts. The results show that there are two opposite cases to consider dependent on the values of γ, the ratio of the two specific heats. Thus, first, if $3\gamma > 4$, as the gas loses heat the sphere contracts and the temperature rises; whereas second, if $3\gamma < 4$, with loss of heat the sphere expands and the temperature falls. Thus a gas in which $\gamma = 4/3$ will condense as it loses heat until a liquid nucleus is formed at its centre. After that stage is reached the results obtained for a wholly gaseous mass will no longer apply. E. H. B.

1018. *Thermal Conductivity at Low Temperatures.* **P. Macchia.** (Accad. Lincei, Atti, 16. pp. 507–517, April 7, 1907.)—The experiments on lead [see Abstract No. 676 (1907)] were extended to a temperature of −185° by means of liquid air. The thermal conductivity of lead does not increase to the same extent as that of bismuth when cooled. For bismuth at −183° and 18° Giebe found a ratio of 2·86, whereas for lead at −183° and 25° the author finds only 1·81. The ratio of thermal to electrical conductivity for lead is 1,871 at 25°, 1,788 at −12°, and 650 at −183°. Divided by the absolute temperature, these figures give the values 6·3, 6·8, and 7·2 respectively, in fair agreement with Lorenz's law. E. E. F.

1019. *Specific Heats of Liquids at Low Temperatures.* **A. Battelli.** (Accad. Lincei, Atti, 16. pp. 243–257, March 3, 1907.)—Specific heats were determined by congealing the liquids in a Dewar bulb, allowing them to liquefy, and heating them by means of a known current through a resistance of nickelin wire. The temperatures before and after heating were read by means of a copper-constantan thermo-couple. Half the results are given in the following table, where *t* is the mean temperature and *c* the specific heat :—

	t.	*c.*		*t.*	*c.*
Ethyl ether	−91·37	0·514	Ethyl alcohol	−90·7	0·457
”	−50·05	0·517	”	−71·2	0·463
”	−21·8	0·523	”	−27·97	0·497
Toluol	−92·02	0·353			
”	−71·52	0·357	Amyl alcohol	−49·15	0·455
”	−25·0	0·380	”	−31·7	0·469
Ethyl bromide......	−105·47	0·195	”	−9·55	0·492
”	−66·82	0·199			
”	−28·82	0·205	Carbon bisulphide	−95·75	0·195
Petroleum ether ...	−161·2	0·588	”	−59·4	0·196
” ...	−96·15	0·596	”	−18·23	0·217
” ...	−25·55	0·608			

E. E. F.

1020. *Expansion of Solids at Low Temperatures.* **F. Henning.** (Ann. d. Physik, 22. 4. pp. 631–639, April 4, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The relative mean expansibilities of glass 59^{III}, fused quartz, Berlin porcelain, palladium, platino-iridium, silver, copper, nickel, aluminium, constantan, bronze, brass, and various kinds of iron and steel with respect to platinum between 16° and −191° C. were determined, and the absolute expansibilities were calculated from Scheel's work on platinum [see Abstract No. 431 (1907)]. The change of length on cooling to very low temperatures is less than extrapolation from curves for high temperatures would give, except in the case of brass for which the opposite occurs. The behaviour of fused quartz at low temperatures noted by Scheel is confirmed by the present observations. R. E. B.

1021. *Variation of Specific Heats with Temperature and Density.* **J. P. Dalton.** (Phil. Mag. 13. pp. 525–535, April, 1907.)—Curves are drawn representing $(C_p - C_v)/R$ in terms of reduced volumes for a series of reduced temperatures, van der Waals' characteristic being assumed, and are shown to agree in general outline with those experimentally found for ether. It is deduced that for ether the variation of C_v is comparatively small, that in the liquid phase it varies with the volume more than with the temperature of which it is practically independent, that in the gaseous phase it is independent of the density when this is small and depends on temperature only, that with increasing density it increases, attaining a maximum value at the critical density. The data for air are discordant and cannot be used to test the curves, but these are confirmed by the results found for CO_2. R. E. B.

1022. *Mean Specific Heats between* —185° *and* 20° *C. of Certain Substances.* **P. Nordmeyer** and **A. L. Bernoulli.** (Deutsch. Phys. Gesell., Verh. 9. 8. pp. 175–183, April 30, 1907.)—A method described previously [see Abstract No. 1250 (1906)] was used and the results found, multiplied by 1000, are the following: Hg 32, Ta 33, Au 35, W 36, Tl 38, Mo 62, Ba 68, Ti 82, Cr 86, Ni 92, Fe 95, Si 123, Ca 157, Mg 223, Na 234; white metal I. 45, II. 54, manganese iron 107, $K_2Cr_2O_7$, 109, $KMnO_4$ 141, benzol 176. The mean specific heat of ice between 0° and —185° was found to be 0·345. There is a considerable difference between the number found here for Si and that given before; this is due to difference in the crystalline forms examined. R. E. B.

1023. *Specific Heat of Saturated Vapours.* **J. P. Dalton.** (Phil. Mag. 13. pp. 536–542, April, 1907.)—With the assumptions of van der Waals' characteristic and of the practical constancy of C_v the curve of inversion-points (*i.e.*, of points at which the specific heat of saturated vapour changes sign) is deduced and plotted. From this it appears that no inversion can occur if $\gamma_\infty \equiv (C_p/C_v)_{v=\text{large}} > 1{\cdot}202$, so that for monatomic and diatomic vapours the specific heat of saturated vapour is always negative; and that in general two inversion-temperatures occur which differ the more the less γ_∞. Experimental evidence for these results is examined, but qualitative confirmation only is found by reason of the defective data at command. R. E. B.

1024. *Latent Heat of Water.* **L. F. Guttmann.** (Journ. Phys. Chem. 11. pp. 279–282, April, 1907.)—Regnault's value, corrected for error in his assumed value for the specific heat of ice and in his formula for the specific heat of water at ordinary temperatures, becomes 79·59. Smith's value [Abstract No. 2936 (1904)], corrected with the values 1 Clark (15°) = 1·433 volts and 1 calorie = 4·1890 joules, is 79·67. The author considers the latter the most probable value of the latent heat. R. E. B.

1025. *Saturation-pressure of Water-vapour.* **F. Henning.** (Ann. d. Physik, 22. 4. pp. 609–630, April 4, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—With temperatures as abscissæ the excesses of the saturation-temperatures found by various observers over the saturation-temperatures for the same pressures as given by Thiesen's formula are plotted and discussed, and from these curves is drawn up a table of the most probable values of the saturation-pressures p for temperatures t° C., differing by 10° from 0° to 200° C.; thence the corresponding values of $dp/\partial t$ are calculated, and, by means of Clapeyron's equation and the formula $L = 94{\cdot}210\,(365 - t)^{0{\cdot}31249}$ for the latent heat of vaporisation, the specific volumes of saturated steam, which are further compared with the values found by different observers and also with the calculated specific volumes in the ideal state. R. E. B.

1026. *Vaporisation.* **R. Tandler.** (Zeitschr. Phys. Chem. 58. pp. 758–759, April 9, 1907.)—A general law already given is $\pi = r^c$, where π is the ratio of the saturation-pressures at temperatures T, T_0, the ratio of which is r, and $c \equiv \lambda_0/RT_0$, λ_0 being the heat of vaporisation at T_0. The value of c is taken as 10·6 for all substances if the standard temperature T_0 is the boiling-point under 1 atmo. The constancy of c (Trouton's law) is thus explained by its being $\log \pi / \log r$, the constancy of which indicates that vaporisation is a "colligative" process which takes place between the molecules of a body as such and is independent of the special properties of the body itself. The variations from this value 10·6 of the values of c and $\log \pi / \log r$ deduced from the results of observations are explained as due to dissociation or association, and its relation to other empirical laws is discussed. R. E. B.

1027. *Dissociation of Steam by a Hot Wire.* **A. Holt, Jr.** (Phil. Mag. 13. pp. 630–635, May, 1907.)—The results of some experiments on the dissociation of steam produced by a hot platinum wire, though consistent with themselves, being at high temperatures decidedly lower than those obtained by Nernst and Wartenberg [Abstract No. 1808 (1905)], they have been repeated under circumstances which allow of the collection and examination of the gases in the immediate neighbourhood of the wire and at a distance from it so that the effect, if any, of the emanation from the glowing platinum might be investigated. The previous results were confirmed, the values obtained for the dissociation at low temperatures (950° C.) being slightly higher than those of Langmuir and of Nernst and Wartenberg, but being only about one-seventh of them at the highest temperatures employed (1,760° C.), while no appreciable recombination of the dissociated gases seems to be effected by the platinum spray. The cause of this discrepancy of results is being investigated. R. E. B.

1028. *Theory of Linde's Condensation-Pump.* **J. Rožič.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1559–1570, Dec., 1906.)—The incorrectness of the explanation of the action of this machine given by Pictet (who maintains that the cooling produced on expansion is due to the performance of external work and not at all of internal work) is demonstrated; and, by considering a simplified closed cycle, with the assumption of van der Waals' characteristic, it is shown that the Kelvin-Joule empirical expression $\delta T/\delta p = a/T^2$ for the cooling per unit drop of pressure on expansion is not of general validity, especially for gases of the air-type. R. E. B.

1029. *Formulation of the First Law of Thermodynamics.* **A. A. Satkevich.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. Part II. pp. 397–408, 1906.)—

The first law of thermodynamics, formulated in the usual manner, is expressed by the equation: $W . DQ = DJ + p . dV$, where DQ is the quantity of heat disengaged, DJ the increase in the internal energy of the system, p and V the pressure and volume of the gas and W the mechanical equivalent of heat. The hypotheses assumed by this expression are: (1) the system has no kinetic energy; (2) the work of gravity or of external forces generally is practically zero and (3) the external pressure is uniform and normal to the surface. The author shows not only that these hypotheses are superfluous, but that they obscure the true meaning of the law. It is easily shown from the hydrodynamical equations relating to imperfect fluids that the increase in the kinetic energy of the element of the system is produced by: (1) the work of external forces acting on the fluid mass; (2) part of the work of pressures of which the differential has the form $V . d_{xyz}p$ and (3) by the supplementary work of viscosity (DR) corresponding to the transport of the element without deformation. On comparing this result with the most general expression of the principle of conservation of energy, the first law of thermodynamics is easily deduced in the form: $W . DQ = DJ + p . dV + DR$, the terms corresponding with purely mechanical modifications being annulled. The term, DR, by which this expression differs from that given above, disappears when the forces of friction become negligible. The formulation of this law proposed by the author is not even restricted to the case of the stationary state usual in hydraulic problems, the only condition assumed being that of continuity of the motion. T. H. P.

REFERENCES.

1030. *Melting-point of Carbon.* **R. H. McCrae.** (Chem. News, 94. p. 314, Dec. 28, 1906.)—A rough calculation, made on a somewhat doubtful basis, places the melting-point of carbon at 4,000° and its critical temperature at 14,000° C. T. M. L.

1031. *Specific Heats and Specific Gravity of Allotropes of Solid Elements.* **A. Wigand.** (Ann. d. Physik, 22. 1. pp. 64–98, Dec. 28, 1906. Extract from Inaug. Dissertation, Marburg.)—The author's work concerns mainly the experimental confirmation of Richarz's law (Gesell. Naturw. Marburg, Sitz. Ber. p. 61, 1904), that the specific heats of allotropic forms of the same element are smaller the greater the sp. gr. The substances examined are arsenic, sulphur, tin, phosphorus, carbon, boron, silicium, selenium, and tellurium. It is found that in the case of all these substances Richarz's rule holds. L. H. W.

1032. *Saturation-constants with van der Waals' Characteristic.* **J. P. Dalton.** (Phil. Mag. 13. pp. 517–524, April, 1907.)—By application of Clausius' method of calculation to van der Waals' characteristic the values of the reduced saturation-pressures and reduced saturation-densities for the liquid and gaseous phases are determined for values of the reduced temperature differing by 0·01 from 0·2 to 1. The results are compared with van der Waals' vapour-pressure law and Cailletet and Mathias' law of the straight diameter. R. E. B.

1033. *Two Known Objections to the H-Theorem.* **P. Ehrenfest** and **T. Ehrenfest.** (Phys. Zeitschr. 8. pp. 311–314, May 1, 1907.)—Boltzmann's criticism of the objections raised by Loschmidt and Zermelo against the H-theorem shows that they rest on a purely geometrical, and not a mechanical, difficulty; this difficulty, which occurs in a much simpler probability problem proposed by Boltzmann to illustrate his criticism, is here examined, and it is concluded that neither objection is of such character as to form a real contradiction of Boltzmann's conclusion that with exceeding probability $\partial H/\partial t$ is negative for high values of H. R. E. B.

SOUND.

1034. *Electromagnetic Tuning Apparatus.* (West. Electn. 40. p. 257, March 28, 1907.)—Describes the apparatus for which a U.S. patent has been granted to L. R. Wheeler. It has a carbon transmitter, at the mouth of which is produced the sound under examination. The transmitter is in connection with an induction arrangement which turns a needle and thus indicates upon a direct-reading scale the pitch of the sound in question. E. H. B.

1035. *Demonstration of Sound Vibrations.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 9. 7. pp. 116–119, April 15, 1907.)—Sound is received in a conical chamber whose far end is closed by a membrane fitted with a mirror which reflects the light from an arc lamp on to a mirror rotating about a vertical axis. The rotation alone gives a horizontal straight line of light on the screen. The vibrations of the membrane, due to the incident sound waves, superpose upon this a vertical vibration. Thus the resultant is a sine graph for a simple tone or the corresponding compound wavy curve for any given compound tone. [Precisely this method was devised by J. G. McKendrick and by J. Erskine-Murray, and was used at Nottingham as far back as 1901.] E. H. B.

1036. *Simultaneous Vibration Curves of a String and its Bridge.* **E. H. Barton** and **J. Penzer.** (Phil. Mag. 13. pp. 446–452, April, 1907.)—For the horizontal motion of the bridge in the direction parallel to the length of the string a special form of optical lever is adopted, in which not only are the planes of rotation and of incidence inclined, but also the normal to the mirror is inclined to the axis of rotation of the lever. The results are given on 47 photographs (reproduced) showing the vibration of the bridge both vertically and parallel to the string, which was plucked, bowed, or excited by a tuning-fork. The bridge as a rule exhibits a more complex motion than the string. E. E. F.

1037. *Demonstration of Sound Propagation.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 9. 7. pp. 113–115, April 15, 1907.)—A special U-tube due to Töpler has a membrane on the end of each limb provided with a concave mirror by which a real image of a Nernst filament is projected. Thus on pressing a bulb fitted near one end of the Töpler tube, a pulse is made which immediately affects the membrane at that end, and a little later when the sound has travelled along the U-tube, affects the membrane at the other end, the two images being seen to move successively on the screen. The total length of the U-tube is of the order 112 metres. E. H. B.

1038. *Church Bell and Heavy Firing.* (Nature, 75. p. 541, April 4, 1907. From the "West Sussex Gazette.")—The question is here raised as to whether any instances are known of a church bell being cracked by intense sound waves from explosions. It is suggested that this happened recently at

Appledram. Three volleys were fired by a naval party of twenty-four men over the grave of a seaman buried in the churchyard. On the evening of the same day one of the church bells, nearly six hundred years old, was found to be cracked. The firing party was only about a dozen yards from the belfry, but no windows were broken in the church. E. H. B.

1039. *Acoustic Yield of the Telephone.* **H. Abraham.** (Comptes Rendus, 144. pp. 906–908, April 29, 1907. Electrician, 59. p. 307, June 7, 1907. Translation.)—The currents received by the telephone start vibrations in the membrane which in turn moves the air and a part of the energy of these aerial vibrations reach the ear. The present note inquires as to the ratio of the sonorous energy utilised by the ear to the electrical energy supplied by the line. A sufficiently close (and too low) estimate of the latter is made by taking the product of resistance of receiver and square of current. An estimate (in excess) is then made of the energy received by the ear from observations on the displacement and elastic constraint of the membrane. It is thus concluded that, apart from resonance, the best telephone does not transmit to the ear the thousandth part of the energy that it receives from the line. E. H. B.

1040. *Appreciation of Phase-difference in Sound Waves.* **L. T. More** and **H. S. Fry.** (Phil. Mag. 13. pp. 452–459, April, 1907.)—The work here described was carried out in 1902, but at the time was regarded by some psychologists as inconclusive. Publication was accordingly deferred until additional work could be done. But as Rayleigh has recently published work upon the same subject [Abstract No. 444 (1907)], his method differing considerably from that of the present authors, they now publish in spite of some incompleteness. Their work is as follows: A listener seated himself at the centre of a large circle marked on the floor of a room. The circle was divided by radii every 22½°, so that 0° was directly behind him and 180° in front, + 90° being to his right and − 90° to his left. A glass funnel, 18·5 cm. in diam., was mounted horizontally on a table about 7 ft. behind him. Heavy rubber tubing connected the funnel to a Y-tube and so to the two ears of the listener. By the introduction of special glass tubes of various lengths at either side the lengths of these branches could be readily altered without the listener's knowledge. Fourteen different students of the college assisted, and to be sure they might not be biassed in their judgments, they remained unacquainted with the purpose of the experiment. In experimenting, a tuning-fork or the voice singing an open vowel at the same pitch was sounded at the mouth of the funnel. The listener was then asked to locate the direction from which the sound appeared to come; this direction was compared with the angles of the circle, and the relative lengths of the branch tubes were measured. The results, in general terms, prove that when the branch tubes were of exactly equal length, the sound seemed to come from behind, but if one was longer than the other, by say 2 cm., the direction of the sound was shifted to the right or left; when the tube to the left ear was the longer the sound came from the right, and *vice versâ*. However the different observers might vary as to the exact angle, they were unanimous so far. E. H. B.

1041. *Direction by Submarine Sounds.* **L. I. Blake.** (Electrical World, 49. pp. 754–755, April 13, 1907.)—One of the methods at present employed by the Submarine Signal Co., of Boston, for locating the source of a submarine sound signal is to attach two iron tanks, one to the port and the other to the starboard wall, inside a vessel below the water-line and toward the bow. In each of these tanks, which are filled with water, is suspended a microphonic transmitter which is connected through a port and starboard indicator box to a receiving telephone in the pilot house. According to the ship's course, the different intensities of the sounds received locate the direction of the sound source. In everyday practice this is successfully done to within a half of a point. The generally accepted hypothesis that a vessel in the path of a submarine sound casts an acoustic shadow, has been used to explain this difference in intensity. It is to be observed, however, that marked differences in intensity occur on the *exposed* side of the vessel, where no shadow exists. The sound is louder when the source is abeam than in any other position. Further, there are decided differences in the quality of the sound delivered into the two tanks—even when these are in the alleged shadow. The difference in quality, although with the majority of observers unconsciously perceived, is, the author believes, a larger factor than intensity in determining sound direction, and is not explainable on a geometric shadow principle. These points are then mathematically discussed and shown to be in accordance with Huyghens' principle, the diffraction phenomena varying for the different simple tones of the compound sound from the signal bell. [See also Abstracts Nos. 444, 683 (1907), and preceding Abstract.] E. H. B.

1042. *Objective Combination-tones with the Singing Arc.* **E. Waetzmann.** (Phys Zeitschr. 8. pp. 846–847, May 15, 1907. Phys. Inst., Breslau, March, 1907.)—A singing arc with microphone in circuit will reproduce several combination-tones, and especially the differential tone of the first order, as well as the separate notes of two primes of different frequency which are caused to affect the microphone. That the differential tone is a real note and not a purely subjective effect is proved by the fact that it can be reinforced by a suitable resonator. As to where the combination-tones have their origin, in the arc or in the microphone membrane, the results of Schaefer [Abstract No. 1760 (1905)] and of the author [Abstract No. 1789 (1906)] would appear to indicate the latter. An experiment is described in which the single microphone is replaced by two in parallel, placed in different rooms and each exposed to only one of the prime tones With this arrangement, although the phenomenon was weakened and less distinct, objective combination-tones were also obtained, thus proving that the microphone membrane is not the sole source of the combination-tones, but that they can also originate in the arc itself. The experiments are thus confirmatory of Helmholtz's theory of combination-tones. L. H. W.

1043. *Modulation in Just Intonation.* **W. C. Woodland.** (Scientific American, 96. p. 271, March 30, 1907.)—The author suggests that the outstanding difficulty of attaining both just intonation and freedom to modulate with only twelve notes to the octave may be overcome by a slight modification of Cahill's electrical musical device, or "tel-harmonium." [See Abstracts Nos. 1262 (1906) and 445 (1907).] Thus, when using the instrument in the key of C the vibration frequencies might be arranged for just intonation in that key. But when the music progressed to a new key a gear-changing device could be brought into action that would tune the instrument for the new keys. E. H. B.

1044. *Helmholtz's Theory of Audition.* **E. Waetzmann.** (Phys. Zeitschr. 8. pp. 307–310, May 1, 1907. Extract from Habilitationsschrift, Breslau, 1907.)—This paper deals with Helmholtz's theory of the part played by the radial fibres of the basilar membrane in the act of hearing. The author puts forward the view that the higher-pitched fibres have less damping, and consequently more sharpness of resonance than the lower-pitched fibres of the basilar membrane, and considers this view assists in the explanation of some experimental phenomena. He concludes that Helmholtz's theory is the best by which to explain the phenomena in question. Admittedly there are difficulties in the way, but they are not of such a character as to induce one to part with the theory. [See also Abstracts Nos. 2099 (1904), 1760 and 1764 (1905), and 1789 (1906).] E. H. B.

1045. *Sound-waves of extremely short Length produced by the Discharge of a Condenser.* **W. Altberg.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 3. pp. 53–62, 1907. Ann. d. Physik, 23. 2. pp. 267–276, June 13, 1907.)—The author has been able to measure the length of the aerial vibrations set up by the sparks during the discharge of a condenser, using for this purpose a diffraction grating arrangement and an apparatus consisting of a mica plate suspended by a quartz fibre, by which the pressure of the wave in different directions could be compared. Tables and numerous curves illustrate the results, which are summarised by the author as follows. (1) During the discharge of a condenser definite aerial vibrations are produced; the length of these up to 2 mm. can be calculated from the electrical constants of the oscillatory circuit. (2) The author's method enables measurements to be made of sound vibrations of length 1 mm. [of frequency 332,400 per sec. in air at 0° C.]. These are an octave higher than the shortest acoustic vibrations which were known up to the present time. L. H. W.

REFERENCES.

1046. *Optical Projection of Tuning-fork Vibrations.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 9. 7. pp. 111–112, April 15, 1907.)—Points out that in the optical projection of tuning-fork vibrations, instead of putting one mirror on the outer side of a prong near the end, it is better to put two mirrors on inner sides and at about the middle of the prongs. [See also Abstract No. 785 (1905).] E. H. B.

1047. *Alternating Currents and Sound Vibrations.* **C. Déguisne** and **K. Marbe.** (Phys. Zeitschr. 8. pp. 200–204, April 1, 1907.)—Traces the analogy between alternating currents of various frequencies superposed and compound musical tones. The paper is illustrated with Marbe's smoke figures showing the characteristics of the vibrations in question. [See Abstract No. 682 (1907).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1048. *Relativity in Electromagnetism.* **A. H. Bucherer.** (Phil. Mag. 13. pp. 413–420, April, 1907.)—The author here seeks to explain by a new principle of relativity in electromagnetism the difficulties encountered by the Maxwellian theory in the experimental evidence that terrestrial optics is not influenced by the earth's motion. Guided by the feeling that the *form* of the Maxwellian equations must correspond somehow to the true laws of electromagnetism, he has attempted a new *interpretation* of these equations which should harmonise with facts. Two electromagnetic systems, A and B, are considered in uniform rectilinear motion relatively to each other. Then, in dealing with the dynamical interactions of the systems, the one acted upon (called the passive system) is supposed to experience the same force as it would on the Maxwellian theory on the assumption that it were *at rest in the ether*, and the other system moving relatively to it. This stipulation, that the passive system is invariably the one *at rest*, implies the principle of relativity. The idea is then analytically developed, and it is shown that the choice of the passive one of the two systems in relative motion is arbitrary, *i.e.*, a moving magnetic pole exerts exactly the same force on a *resting* electron as a moving electron on a *resting* pole. It is intended to work out a complete theory of the Fizeau experiment on the basis of the principle of relativity. [See also Abstract No. 1785 (1906).] E. H. B.

1049. *Direct Determination of Electrolytic Ionic Charge.* **H. Pellat.** (Comptes Rendus, 144. pp. 902–904, April 29, 1907.)—It is known that Townsend has shown that the electric charge carried by a gaseous ion is the same as that carried by a monovalent ion in electrolysis. Further, J. J. Thomson having determined the first of these two quantities, the second is indirectly furnished. The present author points out how the charge e, carried by a monovalent electrolytic ion may be directly calculated solely from electrolytic data, and without any reference to the properties of gaseous ions. Reasons were recently adduced by him [Abstract No. 961 (1907)] for believing an atom or an ion to be approximately spherical. To such a sphere moving in an electric field is now applied the formula of Stokes for the velocity v acquired by a sphere of radius r in a medium of viscosity η, whence $v = ne\phi/6\pi\eta r$, where n is the valency and ϕ the field intensity. But, by the definition of the mobility k of an ion, we have $v = k\phi$, whence $r = ne/6\pi\eta k$. On inserting the values of η and k for water, the product being independent of temperature, we have $r = 7{\cdot}063 \times ne \times 10^{11} \ldots.(1)$. A mass M gm. of the electrolyte is then considered where M is the molecular weight; D being the density, the volume is M/D. If this is occupied by spheres practically touching and in cubical piling, we have $8R^3K = M/D$ or $R^3 = Me/8aD \ldots.(2)$, where 2R is the side of the cube occupied by a molecule, ηK is the number of molecules in M gm., $a = Ke = 9618$ in electromagnetic c.g.s. units. Thus by (1) and (2) we have $e^2 = 8{\cdot}689 \times 10^{-41} \times M\, r^3/n^3\, D\, R^3 \ldots.(3)$. This equation is then applied to mercury, r being written equal to R, $M = 200$, and $D = 13{\cdot}596$. If the valency n be put 1, e is found to be $2{\cdot}3 \times 10^{-20}$, but if n be put 2, then e becomes $0{\cdot}82 \times 10^{-20}$. By the indirect (Thomson-

Townsend) method, taking Thomson's early (1898–99) values, e comes out $2 \cdot 2 \times 10^{-20}$; or, taking the later (1901–2) values, e is found to be $1 \cdot 1 \times 10^{-20}$. Hence the present method gives a good agreement. The radius of an atom is also found from (1) to be—

$$7 \cdot 068 \times 10^{11} \times 1 \cdot 1 \times 10^{-20} = 7 \cdot 8 \times 10^{-9} \text{ cm.}$$

E. H. B.

1050. *Ionic Theory of Conduction in Alloys.* **R. Schenck.** (Phys. Zeitschr. 8. pp. 239–244, April 15, 1907. Communication from the Phys.-chem. Laborat. d. techn. Hochschule, Aachen.)—From a consideration of a number of experimental results obtained by previous observers, the conclusion is drawn that the thermal conductivity of a pure metal is less altered by the addition of a foreign substance than is the electrical conductivity. To explain this the suggestion is made that part of the heat conduction is due to molecules, in addition to that caused by electrons. By the addition of a good conducting metal to another pure metal which is a worse conductor, an alloy is formed whose thermal and electrical conductivities are smaller than those of either of the components. This is accounted for by an increase in the frictional resistance to the motion of the ions and molecules. It is known in the case of a gas that the viscosity of a mixture is greater than that of either of the components. If Ne denotes the number of electron-equivalents in a litre of metal and $N\mu$ the number of molecular-equivalents, call $(Ne + N\mu)/Ne = i$, and Drude's expression for the ratio k/σ of the thermal and electrical conductivities must be modified into $k/\sigma = \frac{4}{3}\left(\frac{i\alpha}{e}\right)^2 T$, where α = temp.-coeff. of kinetic energy for a gm. molecule, T = absolute temperature, and e = charge on electron-equivalent. Forming a similar equation for a pure metal and dividing one equation by the other, i can be found since k/σ is known for various metals and alloys. The results agree fairly well with Drude's from the optical side for the number of electrons in a litre. From a consideration of the thermo-electric properties the conclusion is drawn that the decreased conductivity at higher temperatures is nearly entirely due to increased frictional resistance.

R. S. W.

1051. *Ratio of the Thermal to the Electrical Conductivity.* **J. Koenigsberger.** (Phys. Zeitschr. 8. pp. 237–239, April 15, 1907. Math.-Phys. Inst., Freiburg, Feb., 1907.)—If k is the thermal and σ the electrical conductivity, then, according to the author, Riecke's theory of electronic conduction is the only one that satisfactorily accounts for Wiedemann and Franz's law concerning their ratio. If the conductivity depends wholly on the negative ions, then with rising temperature the number of free ions must *decrease.* The reason that the Wiedemann and Franz law is not more generally true is accounted for by supposing that heat conduction is brought about by the motion of uncharged molecules, while the electrical conductivity is due to charged ions. This supposition accounts for the properties of electrical insulators.

R. S. W.

1052. *Dielectric Theory.* **G. Sagnac.** (Journ. de Physique, 6. pp. 273–277, April, 1907.)—Clausius considers a dielectric as formed by a number of small conducting spheres separated by intervals void of matter. If g is the fraction of the unit of volume occupied by the spheres, then K, the dielectric constant, is given by $K = (1 + 2g)/(1 - g)$. If the elementary spheres are at mutual distances sufficiently great with respect to the radius, each of them, when in an electric field F, acquires an elementary electric moment, which can be calculated as if they were isolated in an electric field, supposed uniform. The electric moment of a dielectric sphere of volume V containing a great number of elementary spheres is the sum of the electric moments of these spheres. The author shows that the electric moment of a conducting sphere in an electric field F has the value $3F/4\pi$ per unit volume. The moment will therefore be $3FV/4\pi$ for a conducting sphere of volume V. Consequently the electric moment of a dielectric sphere is $M=(3/4\pi)FgV$. Thomson's dielectric theory, where the dielectric is considered as continuous and characterised by the dielectric constant K, leads to the value of the moment—

$$M=(3/4\pi)\,[(K-1)/(K+2)]\,FV. \quad \text{Hence } g=(K-1)/(K+2).$$

If the dielectric is compressed or expanded without altering the temperature, and if it be admitted that it remains formed of the same elementary particles closer together or farther apart, then g varies directly as the density d, and the ratio $u=g/d=[(K-1)/(K-2)]d$ remains constant. The value of u is that of the total volume of the elementary spheres in unit mass of the dielectric; this constant of Clausius characterises the dielectric independently of its density. The preceding theory applies also to a dielectric D formed of a homogeneous mixture of two dielectrics D_1 and D_2, whose constants are different, u_1 and u_2. If 100 gm. of D contain p gm. of D_1 and $(100-p)$ gm. of D_2, the total volume of the elementary spheres is $100u=pu_1+(100-p)u_2$, where—

$$\frac{100}{d}\cdot\frac{K-1}{K+2}=\frac{p}{d_1}\cdot\frac{K_1-1}{K_2+2}+\frac{100-p}{d_2}\cdot\frac{K_2-1}{K_2+2}.$$

This formula can be extended for mixtures of several dielectrics. Substituting the square of the index of refraction for K, the constant of refraction of H. A. Lorentz and L. Lorenz is obtained: $u=(n^2-1)/(n^2+2)\,d$ with—

$$\frac{P}{d}\cdot\frac{n^2-1}{n^2+2}=\Sigma\frac{p_i}{d_i}\cdot\frac{n_i^2-1}{n_i^2+2},$$

where $P=\Sigma p_i$. This last formula gives a means of predicting the refractive index of a mixture composed of known weights p_i of different bodies of densities d_i and of refractive indices n_i in the free state. The calculated results agree fairly well with the observed values, notably in the case of solutions made without chemical reaction. A. W.

1053. *Dielectric Theory.* **G. Sagnac.** (Journ. de Physique, 6. pp. 277–279, April, 1907.)—This deals with Fresnel's formula $(n^2-1)/n^2$. If a dielectric plate is placed in an electric field F which is perpendicular to its two faces, the electric moment per unit volume of the polarised dielectric is $I=F(k-1)/4\pi k$, though if the plate conducts as a metal, it has an electric moment per unit volume of $F/4\pi$. Suppose the plate of the dielectric to be made up of thin conducting parallel plates separated from one another, and let g be the total volume of these plates in unit volume of the dielectric. Then the resultant moment per unit volume of the dielectric is $I=Fg/4\pi$. Hence $g=(k-1)/k=(n^2-1)/n^2$. The ratio $g/d=(k-1)/kd=(n^2-1)/n^2d$, where d is the density, is the invariable volume of the constant number of thin plates contained in unit mass of the dielectric, whose density only is supposed to vary. Hence g/d, if the formula $k=n^2$ be admitted, is the dielectric or optic constant of a medium formed of separated conducting laminæ parallel to each other. A. W.

1054. *Electrical Analogy of Thermodynamics.* **F. W. Adler.** (Ann. d. Physik, 22. 3. pp. 587–594, March 5, 1907. Phys. Inst. d. Univ., Zürich, Dec., 1906.)—Mach and Lippmann have described a cyclical process which they claim to be analogous to the process used in demonstrating the second law of thermodynamics. Potential takes the place of pressure, and charge takes the place of volume. The ideal experimental body is supposed to resemble a soap-bubble. The author shows that this cycle is not strictly analogous to the thermodynamic cycle, but to a cycle of isopiestics and adiabatics. If the analogy with isothermals is to be maintained, potential must be substituted for the square root of the pressure, and electrostatic capacity must be substituted for volume. The sphere expands while placed in successive contact with bodies at potentials calculated to maintain the energy of the sphere rV^2 constant. Then the sphere is further expanded without contact, thus leaving its charge constant. It is then compressed along an iso-energetic curve, and finally compressed along a curve of constant quantity. Then the work W_1 imparted along the first iso-energetic is to the work W_2 given up along the second iso-energetic as the energy of the first $(V^2r)_1$ to the energy of the second $(V^2r)_2$. This is strictly analogous to the second law in the form $Q_1/Q_2=(pv)_1/(pv)_2$. E. E. F.

1055. *Dielectric Hysteresis.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1659–1690, Dec., 1906.)—The presence of a turning moment in a dielectric suspended in a revolving electrostatic field (Arnò) does not of itself prove the existence of hysteresis. Such a turning moment may be experienced by a dielectric entirely free from hysteresis. Let D_i and D_a be the dielectric constants of a suspended dielectric sphere and the medium respectively. Let λ_i and λ_a be the corresponding conductivities. Then if $D_a\lambda_i > D_i\lambda_a$, the sphere experiences a retarding couple. If $D_a\lambda_i < D_i\lambda_a$, the sphere experiences an accelerating couple, and if the two products are equal, the sphere experiences no couple. A retarding couple is experienced by quartz, ebonite, and paraffin in benzol, toluol, benzene, carbon bisulphide, petroleum, olive oil, oil of turpentine, and rape-seed oil. Paraffin, immersed in some liquids, such as benzol and toluol, should show an accelerating couple. No experiments yet made suffice to prove the existence of dielectric hysteresis. But it is certain that if it exists at all, it is "viscous," and independent of the previous history of the dielectric. E. E. F.

1056. *Field due to an Electrified Needle.* **F. B. Young.** (Phil. Mag. 13. pp. 542–551, April, 1907.)—The author determines the relation of the field at the point of an electrified needle to the mechanical force resulting from it, by measuring the pull of an electrified plate on an earth-connected needle opposite and normal to the plate, and protruding through an earthed surface. He finds that the distribution of the charge is practically independent of the length of the needle, if that length exceeds 18 times the radius of curvature of the surface of the point. E. E. F.

1057. *After-effect in Solid Dielectrics.* **L. Malclès.** (Comptes Rendus, 144. pp. 264–266, Feb. 4, 1907.)—Solid dielectrics, such as ebonite, glass, and mica, are embedded in a block of paraffin about twice their thickness. The paraffin has no after-effect, and all after-effect observed is therefore due to the embedded body. The condenser made with such a compound block is connected with two quadrants of a quadrant electrometer, and balanced against another condenser filled with air or paraffin. The gradual displacement of the needle then shows the after-effect in the embedded substance. This shows itself in an increase of the capacity, which is approximately proportional to the p.d. A plate of ebonite 12 mm. thick, subjected to a voltage of 850, shows an increase of capacity amounting to one-fifteenth of its original capacity in 10 min. After that it tends asymptotically towards a maximum. [See also next Abstract.] E. E. F.

1058. *Rate of Recovery of Residual Charge in Electric Condensers.* **F. T. Trouton** and **S. Russ.** (Phil. Mag. 13. pp. 578–588, May, 1907. Paper read before the Physical Soc., March 8, 1907. Electrician, 58. p. 893; with Discussion, March 22, 1907. Abstract.)—Rankine and Phillips have investigated the rate of recovery of solids from strain by a method in which the strain is kept constant while the stress disappears. [Abstract No. 1675 (1905).] The analogous case of a condenser charged electrically is here investigated. The condenser is charged to a certain potential, discharged, and then the potential between the plates allowed to rise to a certain selected value through the development of the residual charge; this value is then kept constant by allowing the released charge to escape through a measuring instrument. This is effected by allowing the electricity to escape through an ionised air resistance, the ends of which are connected with a quadrant electrometer. With large condensers the released charge can be measured by a galvanometer. The quantity of electricity recovered up to any time t is given by an expression of the type $Q = a \log(t + b)$, which is the expression found by Rankine and others to fit the recovery from overstrain in elastic bodies. R. S. W.

1059. *Potential Measurements in the Atmosphere.* **A. Daunderer.** (Phys. Zeitschr. 8. pp. 281–286, May 1, 1907.)—It is usually assumed that the potential gradient is uniform in the lower layers of the atmosphere, *i.e.*, $dV/dh = a$, and, therefore, that $d^2V/dh^2 = 0$, showing that the density, ρ, of the free electricity is zero. As the result of 486 measurements made between March and the end of June, 1906, the author finds that $\rho = 0{\cdot}616$, and from 768 observations in the preceding three months he finds that $\rho = -0{\cdot}577$. R. S. W.

DISCHARGE AND OSCILLATIONS.

1060. *Influence of Light on Charged Conductors.* **F. Aigner.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1485–1504, Nov., 1906. From the II. phys. Inst. d. Univ., Wien.)—The paper is chiefly a study of photo-electric fatigue (1) of the discharging effect of a negatively charged surface; (2) of the contact p.d. Hallwachs has supposed the vessel containing the active plate to have an influence on the rate of decay of the discharging action, but the present experiments show, if this effect is present, it is very small. The rates of discharge of two plates are measured, and then they are acted upon by different coloured lights. The shorter the wave-length, generally the more active is the light in bringing about fatigue. The contact p.d. is also measured, the comparison plate being one of copper oxide. Most metals become more electro-negative when exposed to light, and again the short wave-lengths are the most efficient in bringing about the change. For amalgamated zinc, as Buisson has already shown, light of wave-length less than 310 $\mu\mu$, causes an increase in the photo-electric activity. This is found to correspond with an increase in the electro-*positive* character of the metal as measured by the contact p.d. Contact p.d. and photo-electric activity are, therefore, closely related. R. S. W.

1061. *Photo-electric Effect at High Temperatures.* **E. Ladenburg.** (Deutsch. Phys. Gesell., Verh. 9. 8. pp. 165–174, April 30, 1907. Phys. Inst. d. Univ., Berlin, March, 1907.)—All previous researches on this subject are vitiated by the effect of the gas surrounding the hot electrode; the effect is here measured in as high a vacuum as it is possible to obtain. The electrode, made of gold, platinum, or iridium, is heated by a current, and the leak is measured by a Dolezalek electrometer using Bronson's method. It is necessary to heat the active electrode some hours before use in order to free it from occluded gas. The temperature ranges between 20° and 820°; a thermo-couple is the measuring instrument. As the temperature is raised the activity increases, reaches a maximum near 100° and then falls. If the heating and cooling be repeated several times this maximum disappears nearly entirely. The relative velocities at different temperatures of the expelled electrons are measured by taking their magnetic deflections; no change in velocity is found. The simplest explanation of the results seems to be that a certain number of the electrons in the metal are caused to resonate by the incident light, and may therefore be expelled. A rise in temperature of the plate does not alter the number resonating to any appreciable extent. The maximum activity near 100° on first heating may be due to water vapour. R. S. W.

1062. *Pseudo-radioactivity of Salts.* **D. Pacini.** (N. Cimento, 13. pp. 182–188, March, 1907.)—It is well known that a radio-active wire wound in a coil between two coaxial cylinders maintained at different potentials shows a unipolar discharging power, a positively charged central cylinder being more easily discharged, owing to the emission of electrons by the wire. Similar effects can be obtained by substituting for the wire a strip of blotting paper on which a salt of uranium has been allowed to crystallise. But the author finds that other salts are equally effective, except that they usually show the opposite polarity. The latter is quantitatively defined as the difference in the rates of discharge for the two signs divided by the rate of discharge of negative electricity. A p.d. of 1,000 volts between the two cylinders produces a polarity 0·6 for negative electricity in the case of sodium sulphate. Magnesium sulphate gives 0·9, ammonium sulphate 0·8, nickel sulphate 0·7 when moist, and 0·1 of a positive polarity when dry. Potassium bichromate and potash alum also show negative polarities. Quinine bisulphate when fresh shows positive polarity, but when left for some time in contact with water vapour it becomes negative. E. E. F.

1063. *Effect of Change of Temperature on Spontaneous Ionisation.* **N. Campbell.** (Phil. Mag. 13. pp. 614–622, May, 1907.)—It is found that when a source of heat is applied to a vessel in which is suspended a conductor connected with an electroscope, the walls of the vessel being at such a potential that a saturation current is sent to the electrode, a temporary rise in the current occurs, but the current falls to its normal value long before the temperature has become steady. When the source of heat is removed a similar temporary decrease in the current occurs. The results of the experiments were very irregular, but they tend to show that a definite quantity of electricity passes from the walls to the electrode on the application of the source of heat, and an equal amount in the opposite direction on withdrawing the source, and that this quantity is independent of the voltage employed. The explanation given is that the air contains charged particles possessing considerably greater mass than the ordinary ions and that these, having settled on the walls and floor of the chamber, are disturbed by the convection currents set up on heating. Other effects are described which bear upon this hypothesis. S. G. S.

1064. *Dissipation of Electric Charges in Hot Gases.* **A. Campetti.** (Accad. Sci. Torino, Atti, 42. 1. pp. 47–60, 1906–1907. N. Cimento, 13. pp. 189–202, March, 1907.)—Dissipation took place from platinum, silver and copper electrodes in air, chlorine, and ammonia, heated electrically [see Abstract No. 1265 (1905)]. The results show that chemical action between the metal and the gas has a profound influence. A strong ionisation takes place, the electrode emitting sometimes positive ions, sometimes negative. Positive ions may be emitted by copper in air even below 270° C., but not when immersed in ammonia. The oxidation presents many analogies with that of phosphorus. The author did not determine the mobility of the positive ions. E. E. F.

1065. *Retardation of Electroscopic Leak by Radio-active Substances.* **W. S. Lazarus-Barlow.** (Nature, 75. pp. 559–560, April 11, 1907.)—Some details are given of further experiments which indicate that substances exist which retard the leak of an earthed metal electroscope. The writer found that an aluminium plate which had been kept in proximity to but not in contact with uranium, thoria, or pitchblende, also retarded the electroscopic leak. Gold-leaf electroscopes made of $\frac{1}{8}$-in. lead were used, the earthing of electroscopes of aluminium was complete, and effects of induction and alteration of capacity were eliminated. Recent repetition of the original experiments confirms the results previously obtained. [The first communication of the author was read before the Royal Society, April 5, 1906, but not published except in "Archives of the Middlesex Hospital," vol. 7.—Ed.] J. J. S.

1066. *Discharge of Negative Electricity from Hot Calcium and Lime.* **F. Horton.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 149–170, May 5, 1907. Proc., Ser. A. 79. pp. 96–97, April 24, 1907. Abstract.)—The emission of negative ions from hot platinum in an atmosphere of helium or argon is studied and is found to be practically the same as in air or oxygen. It is found to obey the Richardson formula, $x = A\theta^{\frac{1}{2}}e^{-Q/2\theta}$; A is supposed by Richardson to represent the number of electrons per c.cm. of the metal, and Q the work done by a gm.-mol. of electrons in escaping. If the platinum kathode is allowed to stand some time with a very low gas pressure a large increase in leak is found. This seems to be caused by the appearance of a dark substance on the platinum, which may be due to the action of mercury vapour on the kathode. Calcium is next deposited on the platinum, when it is found that the leak is very greatly increased. The Richardson formula is obeyed less accurately, Q is greatly decreased, as is also A, *i.e.*, the energy required to drag an electron from calcium is less than in the case of platinum, while the number per c.cm. is decreased. The calcium is next oxidised to lime. The leak now is enormously increased, although Q is increased. A is 10^7 times its value for calcium. The agreement with the equation is not so good as in the previous cases. The author concludes that A has not the theoretical significance attributed to it by Richardson. As in the case of platinum, it is found that hydrogen greatly increases the leak from calcium or lime. When the current density reaches a certain value, using calcium or lime, a faint luminosity appears, sometimes on the anode at others on the kathode; in the latter case there is always a large increase in the current. Altering the p.d. causes it to travel from the anode to the kathode. R. S. W.

1067. *Velocity of Ions in Flames.* **E. Gold.** (Roy. Soc., Proc. Ser. A. 79. pp. 43–66, March 12, 1907.)—Gives an account of experiments on the electric conductivity of a coal-gas flame, made with the object of determining the velocities of the negative ions in the flame produced either by the ionisation of salt vapours or by the ionisation of the flame gases. Two methods were used, and the results were concordant. The first method depends on a determination of the ratio between the potential gradient in the flame at some distance from the electrodes and the current flowing through it. This method was used to determine the velocities of the ions of the flame gases. The second method depends on finding the potential gradient necessary to cause the negative ions due to salt vapour to move across the flame from one electrode to the other while carried upward with the stream of gas. The velocity of negative ions is found to be 10,000 cm./sec. for a gradient of 1 volt/cm. The value 1,000 cm./sec. obtained by other observers is based upon the assumption of a uniform gradient. The correct value makes it probable that the negative ions are electrons, as their velocity would be 13,000 cm./sec. E. E. F.

1068. *Action of Magnetic Field on Ionised Air in Motion.* **A. Blanc.** (Comptes Rendus, 144. pp. 739–741, April 8, 1907.)—By experiments on air passing through a tube placed between the poles of an electromagnet, the air having been previously ionised by radium bromide, the author found that the negative ions have a greater mobility than the positive ones. The mean ratio deduced from fourteen experiments was 1·32. E. H. B.

1069. *Positive Rays (Canal Rays).* **J. J. Thomson.** (Phil. Mag. 13. pp. 561–575, May, 1907.)—The author suggests that now we know more about the nature of canal rays the term positive rays would be a more appropriate name. The velocity v and the ratio e/m are determined under different conditions; the results seem to show much greater simplicity than those obtained some years since by W. Wien. The rays are shot through a very narrow tube, so as to obtain a fine spot, and fall on a plate dusted with willemite. Between the tube and the screen they pass through an electric field produced between two aluminium plates, and also through a magnetic field produced by a powerful Du Bois magnet. The two fields are parallel, so that the deflections are perpendicular. The remaining part of the discharge tube is screened by iron. In order to avoid the determination of the intensity of the magnetic field at each point of the path an ingenious method is used. This really comes to measuring the sag in a thin, flexible wire carrying a known current and subject to the same field. If y and x are the displacements of the phosphorescent spot produced by the magnetic and electric fields respectively, then it is shown that $y = Be/mv$ and $x = Ae/mv^2$ where B and A are known constants. Hence—

$$y/x = (B/A)v \text{ and } y^2/x = (B^2/A)e/m.$$

Thus from the first of these two equations it is seen that if a pencil is made up of rays having a constant velocity but all values of e/m up to a maximum, the spot of light will be spread out by the two fields into a finite straight line passing through the origin. If two velocities are present there will be two such lines. If e/m is constant and the velocities have all values up to a maximum, the second equation shows that the line will become part of a parabola. Each of these types is found experimentally. At pressures 0·02 mm. of air the patch of light shows the presence of positive ions, but also a weaker phosphorescence due to negative ions. The spot due to the positive rays becomes a straight line showing a constant velocity, but values of e/m ranging from zero to 10^4. This maximum value is that possessed by a hydrogen atom. The value of e/m for the negative rays, instead of being the usual $1{\cdot}7 \times 10^7$, is less than 10^4. Wien's hypothesis that the ratio e/m varies on account of condensation of other molecules round the charged centres is rejected. It is supposed that during part of their path the positive rays may be uncharged, on account of their picking up a negative corpuscle, and so their deflection is reduced. If more than one corpuscle is attached a heavy negative ion is formed, and it is these that are detected in the experiments. In hydrogen at a like pressure similar results are obtained, but in addition another maximum value of e/m is found, viz., 5×10^3. In helium two values of e/m are found, one 10^4 as in air and hydrogen, the other ½ this. This is the only case, except for hydrogen, where e/m corresponds to the atomic weight of the gas. Argon gives results similar to air. In every case great care was taken to exclude hydrogen, and it is thought that $e/m = 10^4$ does not arise from this gas present as an impurity. At low pressures, no matter what the gas, two values of e/m are found, viz., 10^4 and 5×10^3, *i.e.*, the carriers are the same for all substances. The addition of known gases as impurities did not give different values. R. S. W.

1070. *Specific Charge of Kathode Particles.* **A. Bestelmeyer.** (Ann. d. Physik, 22. 3. pp. 429–447, March 5, 1907. Phys. Inst. d. Univ., Göttingen, May 15, 1906.)—The kathode rays produced by the impact of Röntgen rays upon a heavy metal may be utilised to determine the ratio e/m under specially favourable conditions. The author's results give $1{\cdot}72 \times 10^7$, instead of Simon's value $1{\cdot}886 \times 10^7$. He used a method in which the magnetic and the electric fields were crossed, instead of being parallel as in Kaufmann's method. The forces exerted on the electrons by the two fields were opposite. Out of the diffused bundle of kathode rays possessing various directions and velocities, a pencil of certain velocity, propagated in one plane, was singled out by the magnetic and electric forces, and for this pencil the magnetic radius of curvature was determined in a known magnetic field. Since the electrons traverse the condenser in an approximately straight line, the condenser plates may be brought very close together, thus increasing the sharpness of demarcation of the electric field ten times. Besides, only the end of the electric field is of any consequence, not the beginning. The origin of the electron rays is practically a slit, instead of being a point as in Kaufmann's experiment, and this circumstance secures a greater intensity of the photographic impression. It also facilitates the measurement of the deflection, since the distance between two slit images is more easily measured than the position of a point. The author finds that the speed of the kathode rays generated by Röntgen rays is sensibly independent of the intensity of the kathode rays, and increases with the hardness of the tube. The ratio *e/m* varies perceptibly with the speed, but the variation is not sufficiently definite to decide between the three rival theories of the constitution of the electron. The deviations from all are increased. E. E. F.

1071. *New Phenomena in the Positive Column of the Glow Discharge.* **J. E. Lilienfeld.** (Deutsch. Phys. Gesell., Verh. 9. 7. pp. 125–135, April 15, 1907. Phys. Inst. d. Univ., Leipzig, March 20, 1907.)—A continuation of the researches to which the author was led by observing a peculiar red fluorescence on the glass of a vacuum tube in which the discharge was taking place. This brilliant red fluorescence only occurred when the vacuum was very high, and the author traces its origin to the regular movement of positively charged particles in the direction from the kathode to the anode. In the present paper an account is given of further investigations of the same phenomena, and an apparatus is described by means of which the stream of particles was obtained in a side tube and there subjected to both an electrostatic and a magnetic field which resulted in the deflection of the stream and movement of the fluorescent patch on the walls of the tube. [Compare J. J. Thomson, Abstract No. 1069 (1907).] The simultaneous action of these electric and magnetic fields resulted in the drawing out of the small round patch of red fluorescence on the end of the observation tube into a long straight line, or with crosswise application of the deflections into a figure of S. The moving particles acted upon appear thus to be charged, some positively and some negatively, and moreover in a portion of the magnetic-electrostatic spectrum the positive particles appear to possess a greater velocity and a greater value of the quantity *e/m* than the negative. The fields used were about 100 volts and 40 Gauss respectively. By suitable arrangements the negative particles (kathode rays) were completely avoided, and the deflection of the positive particles measured. The edges of the fluorescent patch were somewhat indistinct, rendering accurate observation difficult, but with a magnetic field of intensity 46 Gauss and a static field of 93 volts between two parallel plates, between which the stream of particles was made to pass, the values of v and e/m were found to be: $v = 5 \times 10^9$ to 7×10^9; $e/m = 5 \times 10^7$ to 8×10^7. No great accuracy is claimed for these figures considering the conditions of measurement, and it is doubtful how far the quantity e/m is a constant for the positive particles. The question arises whether the existence of *positive electrons* is indicated. The probable behaviour of a gas atom brought into a space filled with negative electrons is discussed, and the author suggests that part of the energy which causes the intense heating of the walls of the vessel in these experiments (necessitating the use of quartz instead of glass in places) may be due to the falling-to-pieces of the atoms. Various other questions arise and a fruitful field of research seems opening up.

J. J. S.

1072. *Length of Kathode Dark Space with different Currents and Pressures.* **F. W. Aston.** (Roy. Soc., Proc. Ser. A. 79. pp. 80–95, April 24, 1907.)—In a cylindrical tube, if the kathode completely fills the section, it is found that the edge of the dark space is extremely sharp, and the length of the space an easily measurable quantity. This is particularly the case with oxygen. If D = length of dark space, P = pressure of gas, A and B are constants, it is found that

$D = A + B/P$ for values of D between 0·2 and 2 cm. A = about 1 mm. for all the gases tried, B is a constant for any particular gas, and is proportional, not to its mean free path, but roughly to the velocities of its ions as found by Zeleny. If the current density, *c*, is higher than that required to cover the kathode completely, the distance apart of the electrodes has no effect on either D, *c*, or the voltage V, provided that this distance is greater than D. The following two equations are approximately satisfied: $D = A/P + B/\sqrt{c}$, and $V = F\sqrt{c}/P + F$; A and F being proportional to the velocity of the ions. The conclusion is drawn that the dark space may be regarded as a region of positive electrification travelling towards the kathode in which the total positive charge exactly balances the negative charge on the kathode. On this theory, assuming that the velocity varies inversely as the pressure, it is shown that cD^3pV^{-2} should be a constant for a given gas, and this is shown by the experiments to be approximately true. The velocities at the various pressures can be thus calculated, and if then referred to atmospheric pressure they are of the same order as those of Zeleny. It seems, therefore, that there is little alteration of *e/m* for positive ions between 760–0·5 mm. A theory to account for the sharpness of the edge of the dark space is given. R. S. W.

1073. *Theory of the Electric Arc.* **G. Granqvist.** (Ark. för Mat. Astron. och Fysik, Stockholm, 2. Part 1–2, No. 17. pp. 1–19, 1905.)—The author discusses the temperature conditions in the arc, and gives results of experiments which he considers tend to support his view that thermal conduction and temperature distribution are the chief factors to be considered in any theory of the arc [Abstract No. 146 (1904)]. The size of anode surface at different current strengths has been examined; the ratio of the current to such surface is found to fall off fairly rapidly with increase of current (from 0·58 at 3 amps. to 0·45 at 12 amps.), with solid carbons. The greater part of the paper is taken up with a description of the methods employed to test whether the anode and kathode temperature gradients are able to follow the changes of temperature produced at the electrodes when a small (0·2–2 amps.) low-frequency (10–60-∿) alternating current is superposed on the direct current supplying the arc. A condenser of 0·2 mfd. capacity is placed in series with a telephone receiver and in shunt to the arc, contact being made with a slide wire in series with the arc. No point on the slide wire is found to give silence with either solid or cored carbons in the telephone, and it is therefore concluded that a difference of phase $\gtrless 180^\circ$ exists between the variations in current and in potential. The arrangement for ascertaining the value of this phase-displacement is next described. With solid carbons (current 6–8 amps., arc length 0·9–1·3 mm.) the phase-difference is found to vary between 200° and 220°, hence a shift of phase of 20° to 40° is due to the relatively slow propagation of the changes of temperature in the electrodes. With cored carbons (8–10 amps., arc-length 1 mm.) the phase-difference varies from about 18° to 34°; and with solid carbon kathode and cored carbon anode, from 24·5° to 40·5°. In these last two cases $\cos\phi$ is positive and hence the angle ϕ is either in the 1st or 4th quadrant—a quite different condition to the case in which both electrodes were solid carbons. Finally a typical current-voltage curve, obtained by means of a Joubert contact-maker, is given. L. H. W.

1074. *Temperature of the Mercury Arc.* **C. T. Knipp.** (Phys. Rev. 24. pp. 446–447, May, 1907. Abstract of paper read before the Amer. Phys. Soc.) —Using a form of tube like that of the Cooper-Hewitt lamp, but with the electrodes replaced by mercury columns supported by atmospheric pressure, the author has determined the temperature at various points in the arc by means of Cu-Pt thermo-couples. A third electrode was placed midway between the terminals. The pump was kept running during the observations, and the temperature measurements were made by inserting the couples up through the mercury columns. The galvanometer deflections are found to increase steadily as the distance of the couple above the surface of the mercury increases. At 4 amps.—at which approximately the same illumination is obtained as in the commercial lamp—and 20·7 volts the temperature is 147° C. at the anode, 164° at the kathode, and 178° at a point midway between. The same relative distribution of temperature is found to hold for the range of current 3 to 9 amps. L. H. W.

1075. *Oscillations of Higher Order in Electric Sparks.* **G. A. Hemsalech.** (Comptes Rendus, 144. pp. 741–744, April 8, 1907.)—In his theory of the discharge of a condenser, Kirchhoff established a formula which gives a series of oscillations of decreasing periods. Lecher, Rubens, Lamotte, and Drude have all sought by indirect methods to study experimentally these oscillations of superior order. But previous to the experiments here recorded no one has succeeded in demonstrating these higher oscillations in the spark of a condenser discharge. This has now been obtained and a print from a photograph accompanies the paper. The capacity used was 0·0078 mfd., the inductance 0·0125 henry, the spark-length 4·7 mm., and the speed of the photographic film 1,840 cm./sec. The striæ in this figure show the fourth harmonic of the fundamental oscillation, of which the frequency was 16,600 per sec. [See also Abstracts Nos. 1377 (1899), 1272 (1905), and 2104 (1906).] E. H. B.

1076. *Damping and Energy Utilisation with different Transmitter Arrangements in Wireless Telegraphy.* **H. Brandes.** (Ann. d. Physik, 22. 4. pp. 640–658, April 4, 1907. Abbreviation of Inaug. Dissertation, Strassburg, July, 1906. Écl. Électr. 51. pp. 321–324, June 1, 1907.)—Practical work in tuned wireless telegraphy has shown that the logarithmic decrements given by Abraham's formula, deduced theoretically for the case of a straight conducting rod in free space, are generally too large. The author investigates the subject experimentally, using three 37-m. bare wires, supported from a tower and at a distance of 3–3·5 m. from the walls. The wires were two of 1·4 and one of 2 mm. diam. There were earthed electric lighting mains in the tower. The measurements were made on the Bjerknes resonance method, a bolometer and, later, a vacuum thermo-element being used as indicator. The different connections were: I., single (small) wire; II., single (large) wire; III., two wires (small) 7 m. apart; IV., two wires (one large, one small) 3·5 m. apart; V., three wires 3·5 m. apart. The values obtained are shown below:—

	I.	II.	III.	IV.	V.
$\delta =$ log. decrement ……	$0{\cdot}11_4$	$0{\cdot}12_8$	$0{\cdot}19_7$	$0{\cdot}20_3$	$0{\cdot}24_8$

The results confirm the view that δ is often in practice much smaller than theory would indicate. Abraham's theory would require, for the 1·4-mm. wire, $\delta = 0{\cdot}224$, and $\delta = 0{\cdot}282$ for the 2-mm. wire. The experiments also show that the radiation decrement can be raised by using multiple aerials, as is known. The second part deals with an examination of the so-called Braun closed circuit, from which the conclusion is drawn that with multiple aerials the energy is better utilised in the closed circuit than is the case with simple aerials; and that the most advantageous connection is the "mixed," or the combination of direct and inductive excitation as put forward by Braun [Abstract No. 1688 (1904)]. L. H. W.

1077. *Damping Coefficient of an Oscillator.* **F. Conrat.** (Ann. d. Physik, 22. 4. pp. 659–698, April 4, 1907. Écl. Électr. 51. pp. 283–287, May 25, 1907.)—At the suggestion of the late P. Drude the author undertook an experimental investigation of the damping in a straight conductor of finite length. It was found that neighbouring conductors had a great influence on the values obtained. The results may be summarised as follows: The effect of other conductors depends on their distance, natural period, and relative position. To obtain satisfactory measurements in the main oscillator all others must be removed to at least 1¼ times its length (l) from it. The reduction in the radiation from an oscillator is greater in proportion as the free period of the disturbing conductor approaches that of the oscillator; it is, however, still apparent when tuning is obtained by earthing. The radiation entirely disappears when a tuned parallel wire is brought sufficiently near; in the case of an oscillator 2 m. long the distance is approximately $l/8$. Parallel conductors may increase as well as reduce the radiation according to their position. Thus, if a tuned conductor be placed at about 2 m. from an oscillator 2 m. long the radiation is increased about 25 per cent. Between the distances $l/8$ and l the effect of the secondary conductor is nearly a linear function of the distance. The distance at which this function is zero is approximately $3l/4$. If more than one conductor be brought near the oscillator their effect is proportional to their own power of radiation. Under the best conditions the oscillator, consisting of a wire 2 m. long and 1 mm. thick, gave a value 0·28 for its radiation, which is about 7 per cent. less than the theoretical value.

J. E.-M.

1078. *Measurements in Oscillatory Circuits.* **B. Glatzel.** (Deutsch. Phys. Gesell., Verh. 9. 7. pp. 150–159, April 15, 1907.)—The author describes a differential method of measuring capacities down to very small values and a modification of this by which self-inductances can be measured. One difficulty in such measurements consists in the variability of the oscillations to be measured and in the unsteadiness of the spark-gap conditions. The author gets over the difficulty by employing a differential method. Three identical oscillatory circuits are carefully tuned to one another. In two of these circuits thermo-couples are connected to the secondaries of small transformers whose primary forms part of the oscillatory circuit; the third circuit is supplied from a resonance transformer and inductively excites the other two circuits. The two-thermo-couples are connected up in opposition (after tuning has been effected) and the two transformers regulated until there is no deflection on the galvanometer. The capacity C to be measured is then placed in parallel with the known capacity C_1 in one of the opposed oscillatory circuits. C_1 is then altered until resonance is again obtained, as observed by the galvanometer. The capacity C is then equal to the difference between the values of C_1 before and after insertion of C. Capacities down to 1×10^{-6} mfd. can be measured in this way. For the measurement of self-inductances and the obtaining of very complete resonance curves the original description should be referred to. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1079. ***Radium Emanation and the Conductivity of Water.*** **U. Grassi.** (Accad. Lincei, Atti, 16. pp. 179–188, Feb. 8, 1907.)—When hydrogen activated by radium bromide is bubbled through water, the conductivity of the latter is increased [Abstract 2098 (1905)]. Hydrogen bubbled through without radium has the opposite effect. The author tested the effect of radium emanation upon thoroughly purified and dis-aerated water distilled in a vacuum, but found no effect of the emanation upon the conductivity. It appears, therefore, that the effect described is a secondary effect due to a modification in the gas produced by radium rays or emanation. E. E. F.

1080. *Metallic and Electrolytic Conduction.* **R. v. Hasslinger.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1521–1555, Nov., 1906. From the Chem. Laborat. der k.k. deutsch. Univ., Prag.)—The paper is largely a general discussion of the subject. Some new results are the following: Melted sulphur, which has a small conductivity, shows polarisation effects when a current is passed through it. It also serves to ionise other bodies when they are mixed with it. Silver sulphide conducts electrolytically at ordinary temperatures; at lower temperatures the conduction becomes metallic. Copper sulphide conducts like a metal at the temperature of the room; at high temperature the conduction is electrolytic. [Compare Abstract No. 1082 (1907).] R. S. W.

1081. *Electrical Conductivity of Metals under Stress.* **W. E. Williams.** (Phil. Mag. 13. pp. 635–643, May, 1907.)—The most recent experiments on this subject by Lussana and Lissell are in many particulars contradictory of each other, *e.g.*, the former found the resistance of manganin to be decreased by hydrostatic stress, while the latter found an increase proportional to the stress. The metal in the form of thin wire is placed in a rubber sleeve containing oil, this is surrounded by water contained in a closed cylinder, and by means of this water the hydrostatic pressure is produced. As $d\mathrm{R}/\mathrm{R}$ (R is the resistance) is small, being of the order 10^{-5} per atmo., the change is measured by reading the deflection on the galvanometer of a Wheatstone bridge which has been previously balanced. Care must be taken to get rid of the effect of temperature-changes brought about by the application of the stress. The results agree excellently with those of Lissell. Pb and Al show a decrease of resistance, manganin and Bi an increase, in all cases proportional to the stress. It is also found that the resistance of Bi is decreased by tension. R. S. W.

1082. *Conductivity and Thermo-electromotive-force of some Compounds of Heavy Metals.* **K. Bädeker.** (Ann. d. Physik, 22. 4. pp. 749–766, April 4, 1907. Habilitationsschrift. Electrician, 59. pp. 284–285, May 24, 1907. Abstract.)—The difficulty of researches on the electric properties of pure metallic compounds consists in the obtaining of suitable preparations. The present paper describes the preparation in a suitable form of various sulphides, oxides, and iodides, and the observation of their conductivity and the e.m.f. of certain thermo-junctions made between some of the compounds. The thin layers of the compounds, obtained by powdering metals and exposing them to subsequent treatment, proved themselves to be coherent in perhaps the highest attainable degree. The preparations used were obtained by means of kathodic disintegration which produced a metallic union afterwards exposed to the vapour of the metalloid at suitable temperature and vapour pressure, which gave rise to an iodide, sulphide, or selenide. The following table gives the absolute values of the specific resistance of the substances at the temperature of the room, together with some figures for comparison :—

Metallic Conductors.		Electrolytic Conductors.	
Cu	0·0000017	CuI	0·045
Pt	0·000014	30 per cent. H_2SO_4	1·35
Bi	0·00012		
CuS	0·000125		
PbO_2	0·00023 (?)		
CdO	0·0012		
Ag_2S (at 200°)	0·0017		
Graphite	0·0028		
Cu_2O	40		
CuO	400 (?)		

The temperature-coefficient of the best conducting compound, CuS, probably approaches the average value of that for the pure metals. Silver sulphide probably changes about the transformation-point 175° from electrolytic to metallic conduction. Silver selenide conducts as a metal both above and below its transformation-point, 133°. CuI was an abnormal case of high electrolytic conductivity. The thermo-electromotive forces of some metallic conducting compounds joined with copper were measured between 20° and 200°. The results between 0° and 100° together with some previously known values are given in the following table :—

Pt-PtRh	5	microvolts/degree.
Cu-CuS	7·33	" "
CdO-Cu	30	" "
Bi-Sb	100	" "
Cu_2O-Pt	480	" "

[See also Abstract No. 1080 (1907).] J. J. S.

1083. *Peltier-effect for Constantan-Iron.* **E. Lecher.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1505–1520, Nov., 1906. From the phys. Inst. d. Univ., Prag.)—Contradictory results having been obtained in certain investigations on the amount of heat obtained through the Peltier-effect in the case of the combination iron-constantan, new observations were made with a thermo-electric calorimeter devised for the purpose to ascertain the sources of error. The author first verified the assumption that the Peltier-effect changes its sign when the direction of the current is inverted, whilst the numerical value of the constant remains the same. The absolute value of the Peltier-effect for a junction of iron and constantan was then determined at the temperature of 20° C. and found to be $3{\cdot}4 \times 10^{-3}$ gm.-cal. per coulomb, the limits of error being about 4 per cent. J. J. S.

1084. *Dielectric Losses.* **B. Monasch.** (Ann. d. Physik, 22. 5. pp. 905–942, May 2, 1907. Extract from Dissertation, Danzig. Écl. Électr. 51. pp. 377–379, June 15, 1907.)—The main object of the researches described by the author was to ascertain the exact law connecting dielectric loss with field intensity. According to the results obtained by previous experimenters, the loss varies as a power of the field intensity lying between 1·5 and 3. The method employed by the author was suggested to him by M. Wien, and is a zero bridge method. A Wheatstone's bridge is arranged, one of whose arms contains the condenser to be investigated; an adjacent arm contains an air condenser having no appreciable loss connected in series with a variable non-inductive resistance, and the remaining two arms consist of non-inductive resistances. The condenser whose loss is to be investigated may be regarded as equivalent to a perfect condenser (or one exhibiting no loss) shunted by a resistance, and the measurement consists in finding the value of this hypothetical shunting resistance. The conditions for balance are easily deduced on the assumption of a sine wave of p.d. impressed on the bridge. Absolute balance with an ordinary telephone can only be obtained with a pure sine wave, but as this is somewhat difficult to realise, the author used Wien's optical telephone (Wied. Ann. **42**. p. 593; and **44**. p. 681, 1891), which responds to waves of one particular frequency only, and thus enables sharp balance to be obtained quite irrespective of the wave-form, as it responds to the fundamental harmonic only. The method was found by the author to give excellent results, and to be far more sensitive and reliable than any methods previously employed. A capacity of only 0·001 mfd. is sufficient to enable accurate determinations to be carried out—hence small samples of cables (only a few yards long) may be easily tested. A 30-cm. spark induction coil was used as the source of testing e.m.f., and was supplied with either intermittent or alternating current. The testing p.d. ranged from about 1,000 to about 6,000 volts. The most important result arrived at by the author is that *the loss varies as the square of the impressed voltage. This law was found to be accurately true, and not a mere approximation.* Numerous apparent deviations from the law were all traced by the author to other causes. Thus the loss was found to increase very rapidly with rise of temperature in many cases (such as those of glass and ebonite), and for this reason the loss appeared at first to increase more rapidly than in proportion to the square of the voltage. Another apparent deviation from the law occurs in cases where the voltage is sufficiently high to cause brush discharges, the loss due to which increases more rapidly than in proportion to the square of the voltage. The dielectric loss is (for a given voltage) proportional to the capacity, and may, in the case of cables working at ordinary frequencies, be regarded as proportional to the frequency. A. H.

1085. *New Type of Induction Coil.* **O. M. Corbino.** (Atti dell' Assoc. Elettr. Ital. **10**. pp. 123–139, Sept.–Oct., 1906. N. Cimento, **13**. pp. 315–333, April, 1907.)—The current from an accumulator is sent through a first coil whose primary and secondary have an equal number of turns, and from the secondary of the first coil into the primary of a second coil with closed magnetic circuit, which transforms it to a high potential. The new coil is said to offer the advantages of small dimensions and a but slight dispersion of the magnetic flux. E. E. F.

1086. *Mechanical Actions in Electric Conductors.* **P. Bary.** (Écl. Électr. **51**. pp. 37–49, April 13, 1907.)—The electrodynamic attractions of parallel current elements in a conductor have the effect of diminishing the sectional area of the conductor. In solids, owing to their great elasticity, the effect is too small to be observed. In liquids it may be demonstrated by sending a strong current through a narrow channel of the liquid. This requires about 1,000 amps. in mercury. There is a single rupture accompanied by a spark. Capillary force prevents the liquid from recombining. A continued break may be obtained by substituting a vertical jet for a horizontal channel. The Caldwell interrupter, which works both with electrolytes and with mercury, owes its action to this principle. The interruption is accompanied by a disintegration of the mercury or other metal into a black dust. All the less refractory metals may be thus disintegrated, the only apparatus being two vessels communicating by a narrow pipe and capable of being heated to the fusing-point of the metal. The speaking and singing arcs are also due to this strictional effect. In rarefied gases the effect is particularly strong, and it accounts for the fact that discharges through a rarefied gas are invariably discontinuous. E. E. F.

1087. *New Electrometer.* **T. Wulf.** (Annal. Soc. Sci. de Bruxelles, 31. 2. pp. 225–232, 1906–1907. Phys. Zeitschr. 8. pp. 246–248, April 15, 1907. Phys. Inst. d. Ignatius Coll., Valkenburg, Holland.)—Two quartz threads about 6 cm. long are joined together at each end and are slightly weighted at the lower end, the upper end being supported by an amber piece. When they are rendered slightly conducting and are charged they bend outwards throughout their length. This movement is measured by a microscope. Among the advantages claimed are smaller capacity than the gold-leaf electroscope, easier reading, sensitivity tenfold greater, proportionality between the reading and the voltage much closer. It may be modified to form an electrostatic oscillograph. R. S. W.

1088. *Electrolytic Selenium Cell.* **M. Reinganum.** (Phys. Zeitschr. 8. pp. 293–296, May 1, 1907. Phys.-chem. Inst., Freiburg, March 12, 1907.)—Two platinum plates dip into a 3·12 per cent. solution of sulphuric acid, one of the plates being coated with selenium of which an area of 5·9 sq. cm. is bare, the rest being covered with asphalt-lac to insulate it. A current of about 2 milliamps. was sent through the arrangement, when it was found that the ensuing phenomena could be best explained by the assumption that by the illumination of the selenium sheet itself, independently of the electrolyte in contact with it, an electromotive force was set up, which, according to its direction, strengthens or weakens the other already existing e.m.f. [See also Abstract No. 2084 (1906).] E. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

1089. *Demonstration of Phase-differences.* **H. Starke.** (Deutsch. Phys. Gesell., Verh. 9. 7. pp. 160–164, April 15, 1907. Phys. Inst. d. Univ., Greifswald, March, 1907.)—The following method of exhibiting phase-differences to a large audience has been successfully employed by the author. A small synchronous motor driven by the generator which supplies the currents whose phase-relation is to be investigated, carries a black disc across which is pasted a thin strip of white paper to form a radius of the disc. A circular scale divided into degrees surrounds the disc. Each of the two currents whose phase-difference is to be exhibited flows through the primary of an induction coil, and the sparks from the secondaries momentarily illuminate the disc. The angle between the white diameters which appear on the surface of the disc determines the phase-difference (being equal to it if the synchronous motor is a two-pole one). In order to obtain good definition of the white strips large bright sparks are necessary, and these may be obtained by connecting across the secondaries of the induction coils, Leyden jars having a capacity of about 0·005 mfd.; thin, weak sparks result in a blurred appearance of the strips. Instead of using two coils simultaneously, a single coil may be introduced in succession into each of the two circuits.

A Geissler tube may be substituted for the spark-gap, but is not nearly so satisfactory; and an arc lamp may be utilised to illuminate the disc instead of the induction coil and spark-gap, but the results are again greatly inferior to those obtainable with the latter. A number of interesting lecture experiments which may be performed by the aid of the above arrangement are described by the author. A. H.

1090. *Powerful Electromagnet.* **P. Weiss.** (Journ. de Physique, 6. pp. 358–368, May, 1907.)—The importance of the shape of the pole-pieces is first pointed out, and the advantages gained by increasing the windings in their vicinity. The windings are immersed in an oil bath. Spiral tubes through which water is kept flowing keep the oil cool. The arrangement is not unlike that often employed for high-power alternating-current transformers. The results of numerous experiments on the effect of the shape of the pole-pieces are described, and the author's method of winding and shaping the pole-pieces produces an intensity of magnetisation 7 per cent. greater than the best results previously obtained. The following results were obtained with one of the author's magnets constructed by the Oerlikon Co. In the first experiment conical polar pieces were used, the diameter of the smaller ends of the truncated cones being 1 cm., and the air-gap 0·445 cm.

Amps.	4	10	16	20	25
Gauss.........	25,575	32,810	34,670	35,310	35,980

In the second experiment, with the diam. of the narrow end of the cones equal to 2·5 cm. and the air-gap 2 cm., the following results were obtained :—

Amps.	1	2	4	6	8
Gauss.........	1,975	3,965	8,040	11,920	15,180
Amps.	10	14	20	33	50
Gauss.........	17,880	19,560	21,120	22,880	24,100

Finally, with the air-gap equal to 0·42, the ends of the pole-pieces being circular planes 15 cm. in diam., the author obtained the following numbers :—

Amps.	1	3	7	8	10	20
Gauss..................	952	2,898	6,180	6,570	7,220	8,975

A. R.

1091. *Hysteresis and Permeability of Iron.* **L. Schames.** (Ann. d. Physik, 22. 3. pp. 448–468, March 5, 1907. Extract from Dissertation, Würzburg. Écl. Électr. 51. pp. 57–58, April 13, 1907. Electrician, 59. p. 284, May 24, 1907. Abstract.)—Determines the relation between hysteresis loss and periodicity by a purely calorimetric method. The specimens of sheet iron were enclosed in glass vessels ending in capillary tubes and filled with xylol. The frequencies employed were 50, 400, and 500. If the hysteresis losses are reduced to a standard maximum induction they are independent of the period so long as B does not exceed about 10,000. Beyond that point the loss increases with increasing frequency. The demagnetisation is similarly independent of the frequency. In feeble fields the permeability diminishes with increasing frequency, and most of all near its own maximum. On further strengthening the field the permeability at the different frequencies tends towards a constant value, which is the same as that towards which it tends in magnetostatic measurements. The above results give a simple and consistent explanation of the contradictory results of other observers. E. E. F.

1092. *Magnetisation and Resistance of Nickel Wire.* **C. G. Knott.** (Roy. Soc. Edinburgh, Trans. 45. 19. pp. 547–554, 1907.)—In a previous paper the effect of high temperature on the relation between electrical resistance and the longitudinal magnetisation of nickel wire was discussed [Abstract No. 1159 (1904)]. In the present paper the relations between temperature, resistance, and transverse magnetisation of nickel are considered. The nickel was in the form of a flat coil of wire, and was placed in the short air-gap of an electromagnet. A coil of wire heated by the electric current served to raise the temperature, and the resistance of the nickel itself acted as a thermometer. The nickel wire formed one arm of a Wheatstone bridge. Peculiarities in the behaviour of nickel at high temperatures were observed. With a field of 3,800 the percentage change of resistance due to the application of the field steadily falls off as the temperature rises till 260° C. is reached. The resistance-change passes through a minimum as the temperature rises through 295°, and thereafter experiences an abrupt rise in value, reaching a sharp maximum at 310°. The value of the resistance-change then falls off rapidly to a comparatively low value at 344°. Similar behaviour was observed with fields of different strength at about the same temperature. Applying the electron theory, it would appear that electrons suddenly acquire more freedom of motion or greater ease of disentanglement at 320° C. or thereabouts. The breaking-up of groups of magnetic molecules and the rearrangement in stabler configurations may be accompanied by greater freedom of electronic convection. No doubt the effect observed is connected with the loss of magnetic susceptibility which occurs in nickel, and also with the change in sign of the Thomson-effect noted by Tait in 1873. J. J. S.

1093. *Magnetic Behaviour of Nickel Alloys.* **B. V. Hill.** (Phys. Rev. 24. pp. 321–336, April, 1907.)—Partly from the results of his own experiments on the alloys of Cu, Ag and Sn, with Ni, and partly from the results of others with Cr, Mn, Fe, Co, and Au alloys with Ni, the author concludes that there is no simple relation between the atomic weights of the metals and their effect in changing the magnetic transformation-point of Ni. Some rough determinations of the latent heat of transformation of Ni in the case of the 40 per cent. Cu alloy gave the average value 4·48, and the mean specific heat between 20° and 100° of the alloy with 4 per cent. Cu was 0·1080; with 8 per cent. Cu, 0·1141; with 20 per cent. Cu, 0·1145; and with 40 per cent. Cu, 0·1008; these differ by from 3 to 7 per cent. from values calculated as a mean from the composition. Electrical resistance measurements on these Cu-Ni alloys are given. For the detailed results with Ni-Sn and Ni-Ag alloys the original paper should be consulted. F. R.

1094. *Ferromagnetic Compounds of Manganese with Boron, Antimony, and Phosphorus.* **E. Wedekind.** (Ber. Deut. Chem. Gesell. 40. pp. 1259–1269, April 13, 1907. Chem. News, 95. p. 227, May 10, 1907.)—Different investigators have described manganese phosphide as magnetic or as non-magnetic; this supports the author's hypothesis that definite chemical compounds of Mn with other elements are the carriers of ferromagnetism, and a body will or will not be ferromagnetic according to the proportion of the excess of one or other of its component elements. When Sb is added to liquid Mn only one stable compound, MnSb, can be isolated. This is more strongly magnetic than MnB. Both MnB and MnB_2 appear to be ferromagnetic, but as it is difficult to separate them completely, it is considered probable that MnB_2 is non-magnetic. Mn_5P_2 and Mn_3P_2 are distinctly magnetic. MnP could not be prepared. Powdered MnB is more than half as strongly magnetic as powdered iron, whilst compact MnB is about one-quarter as strongly magnetic as soft iron. The compact antimonide is nearly twice as strongly magnetic as MnB. The investigation of the permeability of these compounds presents great difficulties. [See also Abstract No. 2087 (1906).] F. R.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1095. *Results obtained with the Electrodensimeter of Benoist.* **H. Bordier.** (Archives d'Él. Médicale, 15. pp. 247–254, April 10, 1907.)—When the patient is placed on the insulated stool for the purpose of the static bath, better results are obtained when he is in communication with the negative pole than with the positive. In five observations the density on the back of the hand in the former condition gave a mean of 17·6 franklins as compared with 11·7 franklins for the positive pole [see Abstract No. 1292 (1905)]. The addition of condensers to the machine increased the density by 2 franklins. Failure to connect the non-active pole to earth caused a loss of 6 franklins. The application of the electric breeze to the head produces a density which is considerably less than when the patient is subjected to the ordinary electric bath. When the breeze is localised on a given region by the "point," the density obtained varies with the distance, being greater if the distance is increased. If the static bath is administered in the standing position the density is greater than in the usual sitting position. This is, however, due to the loss of electricity from the polished surface of the chair. The density varies inversely with the stature of the patient. The rapidity and regularity of the loss of electricity in a patient who has been charged and subsequently disconnected with the machine is a test of the perfection of insulation. This loss can be measured by the electrodensimeter. H. W. P. Y.

1096. *Röntgen-ray Plate and Tube Tester.* **T. T. Baker.** (Röntgen Soc., Journ. 3. pp. 67–70; Discussion, pp. 70–71, Feb., 1907.)—The author's sensitometer consists of a piece of thick lead sheet pierced with twelve square holes, over each of which is cemented from one up to twelve thicknesses of a film prepared from a gelatine emulsion of lead iodide—this being absorbent of the kathode rays. If this arrangement be examined with the fluorescent screen it shows twelve squares ranging in luminosity from very bright to practically complete (visual) extinction. The method of using the sensitometer is as follows: The tube is fixed with the antikathode 12 in. above the plate, the plane of the former being perfectly parallel to the plane of the plate. The tube is worked with a current of 7 amps. at a constant voltage and an 11-in. spark. An exposure of 1 min. is given, the sensitometer being placed over the plate (in contact), and 8 min. development subsequently given at 60° F. with metol-hydroquinone solution. The apparatus is also useful for roughly determining the relative hardness of focus tubes. Experimenting with sensitive plates, the author found that a plate double-coated with ordinary silver bromide solution generally showed a somewhat less dense deposit with a slightly less vigorous image than a single-coated plate after a 1-min. exposure. H. W. P. Y.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1097. *New Observations on Melting and Crystallisation.* **D. Vorländer.** (Zeitschr. Phys. Chem. 57. pp. 357–364, Dec. 11, 1906. Communication from the chem. Inst. d. Univ., Halle.)—Three substances are described which normally pass direct from the isotropic liquid to the crystalline state, but when overcooled in the absence of solid nuclei, may give a labile anisotropic liquid-crystal phase. Four substances are also described which may exist in one solid and three liquid phases, owing to the existence of two anisotropic liquid-crystal phases. The interesting discovery is recorded of liquid crystals which, when mixed with an isotropic liquid such as bromonaphthalene in which they do not dissolve, collect together in patches or drops which exhibit straight edges and angles. In particular, azoxybromocinnamic ester was observed to give first rods, then polyhedral twin-crystals, then rosettes, then scales and more complex forms. The paper is illustrated by a remarkable series of photographs of liquid crystals which illustrate with extraordinary clearness the properties of these curious substances. T. M. L.

1098. *Action of Light on Sulphur.* **G. A. Rankin.** (Journ. Phys. Chem. 11. pp. 1–8, Jan., 1907.)—By the action of a beam of light, amorphous insoluble sulphur is precipitated from a solution of rhombic sulphur in CS_2; the precipitate redissolves in the dark: the action is therefore reversible, and the influence of ammonia and of H_2S in preventing or hindering precipitation of the insoluble form, may be ascribed to their acceleration of the reverse action. With rising temperature the intensity of the light required to produce precipitation, increases. At constant temperature the intensity of light required for precipitation decreases when the concentration increases. Two isothermal solubility curves were obtained; these give the equilibrium conditions of concentration and intensity of light for CS_2 solutions of sulphur at 22·5° and 40° C.; amorphous and rhombic sulphur are in equilibrium when acted on by a 5-c.p. light at 22·5°, and by a 45-c.p. light at 40°. D. H. J.

1099. *Reduction of Magnesia by Carbon.* **P. Lebeau.** (Comptes Rendus, 144. pp. 799–801, April 15, 1907.)—Magnesia is reduced by carbon in the electric furnace with formation of magnesium and magnesium carbide, which are immediately in a great measure destroyed by the furnace gases, hence the apparent non-reduction of magnesia. The temperature at which reduction takes place is approximately the boiling-point of magnesia. W. H. SI.

1100. *A Silicide of Tungsten (Si_2W).* **E. Defacqz.** (Comptes Rendus, 144. pp. 848–851, April 22, 1907.)—Si_2W has been formed by the author in the electric furnace from mixtures of the 50 per cent. copper silicide with amorphous tungsten, or by reduction by Al, in the presence of sulphur, of a mixture of silica and tungstic anhydride. Using different proportions, various silicides have been formed, and similar methods furnish molybdenum silicides. A method of analysis of Si_2W is described. F. R.

1101. *Double Sulphides of Aluminium and Manganese and Aluminium and Iron.* **M. Houdard.** (Comptes Rendus, 144. pp. 801–804, April 15, 1907.)—By heating together, in a current of hydrogen sulphide, mixtures of Al turnings with MnS or FeS, double sulphides have been prepared corresponding to the formulæ Al_2MnS_4, Al_2FeS_4. The compounds are crystalline, and without visible action on polarised light. W. H. Si.

1102. *Combination of Silicon with Copper in presence of Lead, Bismuth, or Antimony.* **E. Vigouroux.** (Comptes Rendus, 144. pp. 917–920, April 29, 1907.)—When copper is heated with an excess of silicon in presence of Pb, Bi, or Sb, copper silicide only is produced, which floats on the surface of Pb or Bi, but is dissolved by Sb. The product in each case contains approximately 10 per cent. combined silicon, corresponding to the compound Cu_4Si. [See Abstract No. 684 (1906).] W. H. Si.

1103. *Ammonium Amalgam.* **H. Moissan.** (Comptes Rendus, 144. pp. 790–791, April 15, 1907.)—The formation of ammonium amalgam by the action of sodium amalgam upon ammonium chloride or iodide in a medium of liquefied ammonia is less simple than originally supposed, the reaction only taking place in the presence of an excess of sodium, and the ammonium amalgam ceasing to exist as soon as the sodium is removed. By electrolysing a solution of the double iodide of ammonium and mercury in liquefied ammonia, or, better, a solution of 3 gm. NH_4I and 0·5 gm. HgI_2 in 20 gm. of water at —40° C., using a current of about 2·5 amps. at 110 volts, and employing electrodes of Pt-foil, a number of blue filaments are formed at the kathode which, on stopping the current, rapidly decompose, giving off hydrogen and a cloud of mercury. This blue compound is soluble in mercury, and appears to play a part in the preparation of ammonium amalgam. W. H. Si.

1104. *Silicides of Copper.* **E. Rudolfi.** (Zeitschr. Anorg. Chem. 53. 2. pp. 216–227, April 4, 1907. Metallog. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—The author gives the equilibrium diagram of these alloys. The first branch of the freezing-point curve, from 0 to 7·8 per cent. Si, corresponds to the primary crystallisation of a solid solution of Si in Cu, the freezing-point falling to 850° C; up to about 4 per cent. Si this solid solution remains stable down to the ordinary temperature; in the alloys from 4 per cent. to 7·8 per cent. Si the saturated solid solution reacts with the mother-liquor, forming a second series of solid solutions; this solid solution, however, on further cooling undergoes two further transformations, the final result being the formation of a compound to which the author ascribes the formula $Cu_{19}Si_4$. The next branch of the freezing-point curve, from 7·8 to 9·8 per cent. Si, again represents the freezing of a solid solution, but the end of this branch leads to a well-defined eutectic point, whence the freezing curve rises to a maximum corresponding to the compound Cu_3Si, from which the curve falls again to another eutectic point, lying at a concentration of about 18 per cent. Si, corresponding to a eutectic consisting of Cu_3Si and Si. From 19 to 100 per cent. of Si, the freezing-point curve rises in smooth convex form to the freezing-point of Si, crystallisation along this branch being that of pure Si. The author also investigates and describes some further reactions that occur in some of the solid alloys. The paper is illustrated with two diagrams and six photomicrographs. W. Ros.

1105. *Constitution of Copper Alloys.* **L. Guillet.** (Comptes Rendus, 144. pp. 845–848, April 22, 1907.)—The author points out that in the case of the binary alloys of Cu with Zn, Sn, Sb, Al, Mg, and Mn, the fifth type of constitution in each case, starting from the copper-rich end, gives a brittle alloy of similar structure. In the case of the Cu-Mn alloys the minimum at 40 per cent. Mn is regarded as the limiting case of a eutectic. The Cu-Cd alloys form an exception on account of the occurrence of Cu_3Cd. All the alloys consisting of the α solution can be forged or rolled; those formed of two solid solutions of which one is α, can only be rolled hot.

F. R.

1106. *Silver-Lead and Silver-Tin Alloys.* **G. J. Petrenko.** (Zeitschr. Anorg. Chem. 53. 2. pp. 200–211, April 4, 1907. Metallog. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Describes determinations of the equilibrium diagrams of these alloys. In the Ag-Pb series observations of eleven alloys were taken, and the resulting diagram shows a freezing-point curve having two branches, commencing at the freezing-points of pure Pb and pure Ag respectively, and intersecting at a eutectic point corresponding to a concentration of 5 per cent. Pb and a freezing-point of 305° C.; the two branches of the above curve represent the solidification of pure Ag and pure Pb respectively, since the eutectic line is found to extend to both ends of the series, no solid solutions being formed. The only peculiarity about the diagram is that a portion of the freezing-point curve is concave, and the author ascribes this to a change in the molecular structure of the metal. Silver-tin alloys present a more complicated series. The freezing-point curve of this series is very similar to that of the Pb-Ag alloys, showing a long branch sloping from the freezing-point of Ag down to a eutectic point lying very near the Sn end of the series and at a temperature very little below that of the freezing-point of pure Sn. The eutectic line, however, does not extend beyond 82 per cent. Ag, and in addition to the eutectic line two other horizontal lines are shown in the diagram. This diagram is obtained when the alloys are cooled at ordinary rates (*i.e.*, 0·5 to 1 degree C. per sec.). Although the diagram only indicates four groups of alloys, microscopic evidence leads the author to divide the alloys into six groups. Group 1, from 0 to 5 per cent. Sn, have the polygonal structure of homogeneous bodies, and thus represent a series of solid solutions. Group 2, from 5 to 17 per cent. Sn when cooled at a moderately rapid rate; two constituents are visible in these alloys, but these are found to arise from incomplete equilibrium between solid solution and mother-liquor during crystallisation; on gradual solidification, homogeneous structure results. Group 3, 17 to 27 per cent. Sn. Rapidly cooled in the ordinary way these alloys show three constituents; if cooled slowly through the freezing range and then quenched, a homogeneous structure is obtained, but on reheating to 480° and cooling slowly, the structure becomes duplex, a reaction suppressed by the previous quenching then taking place. Group 4, from 27 to 52 per cent. Sn. Here also three constituents are found in rapidly cooled specimens, and their relative proportion, or even their entire presence or absence depends on the rate of cooling. Group 5, 52 to 96·5 per cent. Sn. The structure of these alloys does not in any way depend upon the rate of cooling. The sections show white primary crystals of the compound Ag_3Sn surrounded by the eutectic. Group 6, from 96·5 to 100 per cent. Sn, show primary crystals of pure Sn surrounded by eutectic. The existence of the compound Ag_3Sn is borne out by the facts that the maximum duration of crystallisation at 480° occurs at a concentration of 27 per cent. Sn, corresponding to the above formula, that the alloy containing 27 per cent. Sn shows a homogeneous structure, and that a dimorphous change which occurs in this compound body also shows a maximum at 27 per cent. Sn. The compound Ag_3Sn is formed from the solid solutions of sufficient concentration, but somewhat rapid cooling partly or entirely suppresses this reaction. The paper is illustrated with photomicrographs of the alloys. W. Ros.

1107. *Alloys of Silver with the Metals of the Iron Group.* **G. J. Petrenko.** (Zeitschr. Anorg. Chem. 53. 2. pp. 212–215, April 4, 1907. Metallog. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—The author finds that the freezing-point of Ag is not lowered by the addition of Ni, but that the freezing-point of Ni is lowered some 20° C. by the addition of Ag, a solid solution, saturated at nearly 4 per cent. Ag being formed. The two metals are only partially miscible in the liquid state. These mixed fluids first deposit crystals of the saturated solid solution of Ag in Ni, the whole of the Ni present crystallising in this form, and the remaining silver crystallising as pure Ag at the normal freezing-point of Ag. The author embodies these facts in an equilibrium diagram and illustrates the structure of the alloys. The magnetic change-point of Ni is not affected by the presence of Ag. With Fe and Co, Ag is found to be entirely immiscible in the liquid state, so that no alloys can be formed. The existence of compounds between Ag and metals of the Fe group is thus disproved. W. Ros.

1108. *Alloys of Iron with Tin and Gold.* **E. Isaac** and **G. Tammann.** (Zeitschr. Anorg. Chem. 53. 3. pp. 281–297, April 17, 1907. Metallog. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Describes the thermal analysis and microstructure of these two systems of binary alloys. The authors find that iron and tin are not miscible in all proportions in the fluid state; at a temperature of 1,140° C. the range of non-miscibility extends from 50 to 89 per cent. Sn. Crystallised γ iron is capable of dissolving up to 19 per cent. Sn; the solubility of Sn in a iron is not perceptibly different, and the presence of Sn has no appreciable influence on the temperature at which iron loses its magnetic permeability. Iron and tin form at least one compound, but owing to the formation of two layers, and the sinking of crystals formed in one layer down into the other, the composition of this compound could not be ascertained. This Fe-Sn compound, which is formed at a temperature of 893° C., is less soluble in acids than either component, but not sufficiently so to allow of quantitative separation. This compound undergoes a transformation at 780°; a second series of arrest-points are found at 496°, and unless these represent the formation of a second compound, they must also be ascribed to a second transformation of the higher compound. Gold and iron are mutually soluble in all proportions in the fluid state, and in the solid state form series of solid solutions, except for a gap extending from 28 to 68 per cent. Au at 1,168° C., which gap, however, widens with falling temperature to the range from 18 to 85 per cent. Au. Like Sn, Au has no perceptible influence on the temperature of magnetic transformation in iron. The paper is illustrated with two diagrams and twelve photomicrographs. W. Ros.

1109. *Optical Rotalory Power of Salts in Dilute Solutions.* **F. L. Shinn.** (Journ. Phys. Chem. 11. pp. 201–224, March, 1907.)—Oudemans has put forward the rule that the optical rotation of an active base in dilute solution is independent of the nature of the associated acid, whilst that of an active acid is independent of the associated base. This rule has been confirmed by Hädrich's measurements of the rotatory powers of the salts of conchinine and morphine with the mineral acids, Landolt's measurements of the tartrates and Walden's measurements of the bromocamphorsulphorates. For obvious reasons the antimonyl, arsenyl, and boryl tartrates behave in an exceptional way. The present paper describes a number of measurements made with dilute solutions of a number of alkaloid salts, with the object apparently of discovering exceptions to Oudemans' law. The solutions measured were the nitrates, sulphates, and hydrochlorides of strychnine, brucine, cinchonidine and morphine, and exceptional values were found for the nitrate of cinchonidine and the hydrochloride of morphine, but these would be fully accounted for by errors of 0·04° and 0·03° respectively in the actual readings of the polarimeter, and no great importance can therefore be attached to them. T. M. L.

1110. *Composition and Strength of Cast Iron.* **M. Orthey.** (Metallurgie, 4. pp. 196–200, April 8, 1907.)—Gives the results of experiments from which it is concluded that to obtain high tensile and low bending strength, from 20 to 25 per cent. of the carbon must be in the condition of carbide, this being necessarily accompanied by 1 to 1·5 Si, 0·06 to 0·15 S, 0·5 Mn and 0·2 to 0·5 P, in per cent. In order to obtain high bending strength and low tensile strength Si should be from 1·4 to 2 per cent., and Mn, P and S as low as possible. F. R.

1111. *Behaviour of Potassium Persulphate with certain Salt Solutions.* **R. Pajetta.** (Gazzetta Chim. Ital. 36. 2. pp. 298–304, 1906.)—The solubility of potassium persulphate in water is diminished by the presence of potassium salts and increased by the presence of sodium salts. The author has determined the solubility of the persulphate at 12° in saturated solutions of a number of potassium and sodium salts. The results show that the solubility of potassium persulphate in solutions of sodium salts is a function of their concentration in sodium and that, when the latter is constant for different salt solutions, the solubility of the persulphate is also practically the same in all cases. The potassium persulphate is evidently transformed into the corresponding sodium compound. T. H. P.

1112. *Nature of Pseudo-solutions of Ferric Hydroxide.* I. **F. Giolitti.** II. **F. Giolitti and Battisti.** (Gazzetta Chim. Ital. 36. 2. pp. 157–167 and 433–443, 1906.)—I. Gelatinous ferric hydroxide, obtained by adding excess of ammonia to a solution of a ferric salt, dissolves to a slight extent when washed with pure water, giving a colloidal solution. If the thoroughly washed precipitate is kept in pure water for three or four months, dark nuclei develop which have a diameter of about 7 μ and remain undissolved when the mass is treated with acetic acid. If the opaque, opalescent liquid thus obtained with acetic acid is either kept or centrifugated part of the dissolved matter separates in the form of these nuclei, and a pseudo-solution is also obtained with which small proportions of binary electrolytes yield no precipitate, whilst larger proportions give soluble, and multivalent electrolytes insoluble, precipitates; the solution is, indeed, identical in properties with that prepared by long boiling of ferric acetate (Péan de Saint-Gilles). The formation of nuclei is also observed when the well-washed hydroxide is boiled with water for 24–36 hours, the high temperature favouring the change. Examination of the absorption spectra of solutions of ferric hydroxide prepared in various ways shows that these possess quite different colours. The author discusses the various views held as to the constitution of ferric hydroxides, and concludes that the existence of basic salts is highly improbable. The action of acid only serves to separate the ready-formed nuclei from the non-modified residue. II. The authors have determined the limits of stability of various pseudo-solutions of ferric hydroxide with respect to certain electrolytes, more especially nitric acid. The results show that these limits of stability are not merely a function of the dimensions of the particles constituting the solution, but that they depend also on certain specific causes connected with true chemical actions of the electrolyte on the suspended particles. [Compare Spring, Abstract No. 408 (1901).] T. H. P.

1113. *Ionic Migration in the Natural Diffusion of Acids and of Salts. Diffusion of Electrolytes.* **R. G. Durrant.** (Roy. Soc., Proc. Ser. A. 78. pp. 842–879, Dec. 20, 1906.)—The original experiments were made with jelly, coloured pink with phenol phthalein and enclosed in a tube, the ends of which dipped into hydrochloric acid on the one hand and cupric chloride on the other. Under the influence of the current the jelly became bleached at either end, by the action, presumably, of the hydrogen and chlorine ions driven into the jelly by the current. On stopping the current the bleaching continues at a much slower rate, but the *ratio* of the velocities of the boundaries was practically unchanged, being H : Cl = 5·1 : 1 for natural diffusion as against 5·7 : 1 for diffusion under the influence of the current. A large number of experiments were then made on the effects produced by the diffusion of acids and salts into jellies and solutions in the absence of any e.m.f., and it was found possible to study the progress of natural diffusion by the motion of sharply defined boundaries in aqueous solutions in much the same way as was done in the experiments of Masson and Steele on ionic migration. When an acid was allowed to diffuse into blue alkaline litmus jelly a purple zone was noticed in front of the diffusion front and a yellowish-red zone behind it; the former is presumably due to partial neutralisation of the alkali in the litmus by the advancing hydrogen ions; the latter is attributed to the bleaching effect of the anions left behind. After about 400 hours a colourless zone was sometimes observed well behind the diffusion front, and indeed interposed in the centre of the advancing column of reddened litmus, with a blurred boundary in front and a sharp boundary behind; this zone also was attributed in some way to the bleaching action of an accumulation of anions. Other experiments were made which indicated a reduction of ferric chloride by hydrogen ions diffusing into it from an acid, and a large number of experiments were made on the diffusion of NaCl and $AgNO_3$ into litmus; the results, however, were for the most part very complex, and were largely influenced by the purity of the materials used in preparing the upper layer. The theory of diffusion is discussed, but it does not appear as yet to be possible to explain the whole of the experimental results. T. M. L.

1114. *Theory of Solutions.* **L. Vegard.** (Phil. Mag. 13. pp. 589–618, May, 1907.)—The change of concentration in a binary solution in a field of force where the force is proportional to the ponderable mass (as in the case of gravity) is first investigated. The concentration at any point in the state of equilibrium must be a function of the position, and depends upon mechanical as well as thermodynamic conditions. The details of the calculation cannot be given, but it appears that in the state of equilibrium, on the assumption of incompressibility and of forces having a potential, the concentration must be constant along an equipotential surface, and that at every point the concentration-gradient is proportional to the force, the equation—

$$dc = -dU(\rho_0/\rho)c(1+c)(\partial\rho/\partial c)/(\partial_\rho\pi/\partial c),$$

being finally deduced, where c is the concentration, U the potential, and ρ the density at a point, ρ_0 the density of the pure solvent and π the osmotic pressure, or rather the difference of hydrostatic pressure on the two sides of a membrane that separates the solution and pure solvent. The cases are then considered when the force is that of gravity and when the heavy solution is whirled about a vertical axis. The variation of π with the hydrostatic pressure p on the side of the membrane in contact with the solution is further found to be given by $\partial\pi/\partial p = 1 - \rho_0/\rho - (\rho_0/\rho^2)c(1+c)\partial\rho/\partial c$, which is in accordance with equations found by Planck and Duhem ; and it appears, lastly, that the variation of π with c will be different, according as the pressure during the variation is kept constant on the solution or on the solvent. R. E. B.

1115. *Law of Corresponding Connodes.* **H. Happel.** (Phys. Zeitschr. 8. pp. 204–209, April 1, 1907.)—In investigating corresponding states it is advantageous to plot the curves connecting the reduced values of the pressure and temperature for saturation. The curves for monatomic substances fall near together, but are not absolutely coincident ; the same is the case for most tri- and polyatomic substances ; and between these groups of curves lie the curves for diatomic substances, which also are only approximately coincident. Similarly the value of RT/*pv* at the critical point for the monatomic group is about 2·86, and for the triatomic 3·75, while for the diatomic it is between these numbers, being about 3·36. Absolute coincidence of the curves for any group would argue identical molecular states, which is not to be expected. A difficulty is pointed out in respect of Nernst's criterion of the equality of the molecular weights of a substance in the liquid and gaseous states, and it is observed that, while Eötvös' rule is in harmony with the theory of Kamerlingh Onnes [Abstract No. 2298 (1905)], the constants for the different groups of corresponding substances are different. R. E. B.

1116. *Relation between Osmotic Pressure and Surface Tension.* **A. Battelli** and **A. Stefanini.** (Accad. Lincei, Atti, 16. pp. 11–22, Jan. 6, 1907. N. Cimento, 13. pp. 15–28, Jan. and Feb., 1907.)—In continuation of previous work [see Abstract No. 1989 (1905)] the authors have made a limited number of experimental determinations, and they have also utilised pertinent existing data. It thus appears that dilute solutions (of potassium nitrate, mannite, sodium chloride, &c.) of equal surface tension have the same osmotic pressure and the same vapour pressure ; this result furnishes a new and easy method of establishing the isotony of two liquids ; the method may be especially useful in physiological investigations. The authors are of opinion that the passage of the solvent across a semi-permeable membrane may be due to the evaporation of the liquid and the subsequent condensation of the vapour in the vesicles of which the membrane may be supposed to consist. D. H. J.

REFERENCE.

1117. *Electrochemistry of Lead.* **A. C. Cumming.** (Faraday Soc., Trans. 2. pp. 199–211 ; Discussion, pp. 211–212, Feb., 1907.) [See Abstract No. 557 (1907).]